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ABSTRACT

Five packets comprise the marine science component of an enrichment program for gifted elementary students. Considered in the introductory section are identification (pre/post measure) procedures. Remaining packets address the following topics (subtopics in parentheses): basic marine science laboratory techniques (microscope techniques and metric usage); collection and observation techniques (classification of marine animals and plants); oceanographic instruments (water quality sampling and hydrographic studies); and ideas for individual student projects. A bibliography lists approximately 25 books and 100 films/filmstrips. (CL)

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MARINE SCIENCE

INTRODUCTORY PACKET

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MARINE SCIENCE STUDIES AND EXPOSURES

FOR GIFTED STUDENTS

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MARINE SCIENCE PROGRAM SUPPLIES

Equipment for our program was supplied by the North Kitsap Marine Science Lab. Following is a list of materials from which you can get an idea of what would be needed for your program. The amount would vary according to class size.

stereomicroscope
research phase microscope
monocular microscope
petri dishes
eye droppers
microscope slides
microscope cover slips
10 ml. pipette
gram single pan balance
450 ml. grad. cylinder
large beaker
volume displacement tank
2-liter grad. cylinder
large tank (aquarium)
400 ml. beaker
400 ml. flask
centigrade thermometer
50 ml. grad. cylinder
1 ml. pipette
Thermister temp. gauge
magnifying glass
plastic pan
dissecting kit
fiber tray
herbarium press
test tube and corks
acetone
solvent
small beaker
crayon
hot air
centimeter rulers
potato cores
mortar
funnel
tray
Van Doren bottle
hydrowire
messenger
5 sample jars w/lids
bucket thermometer
Secchi dish
Ule scale
250 ml. beaker
automatic burette
triple beam balance
stereoscope
fathometer--lead line
wax paper
biology paper
razor blade
filter paper strips
potassium chloride solution ($KcrO_4$)
silver nitrate solution ($AgNO_4$)
conversion tables
waste materials bottle
magnetic stirring table
plankton net (fine mesh)
weather station data
putty knife or scraper
dye
finger bowl
assorted shapes
plastic bucket
counting grid
Coastal Marine Plankton (book)
cardboard boxes
tracing paper
sharp scissors
Elmer's Glue
watercolor pens
chart of Liberty Bay
compass
mat board
fathometer chart paper
wax pencils
test tube clamps
test tube holders
alcohol burner or heating element
chemicals (in dropper bottles):
- calcium
- sulfates
- chlorides
- ammonia
- organic matter
- ph

lab apron
sea water
tap water
distilled water
sand
wave board

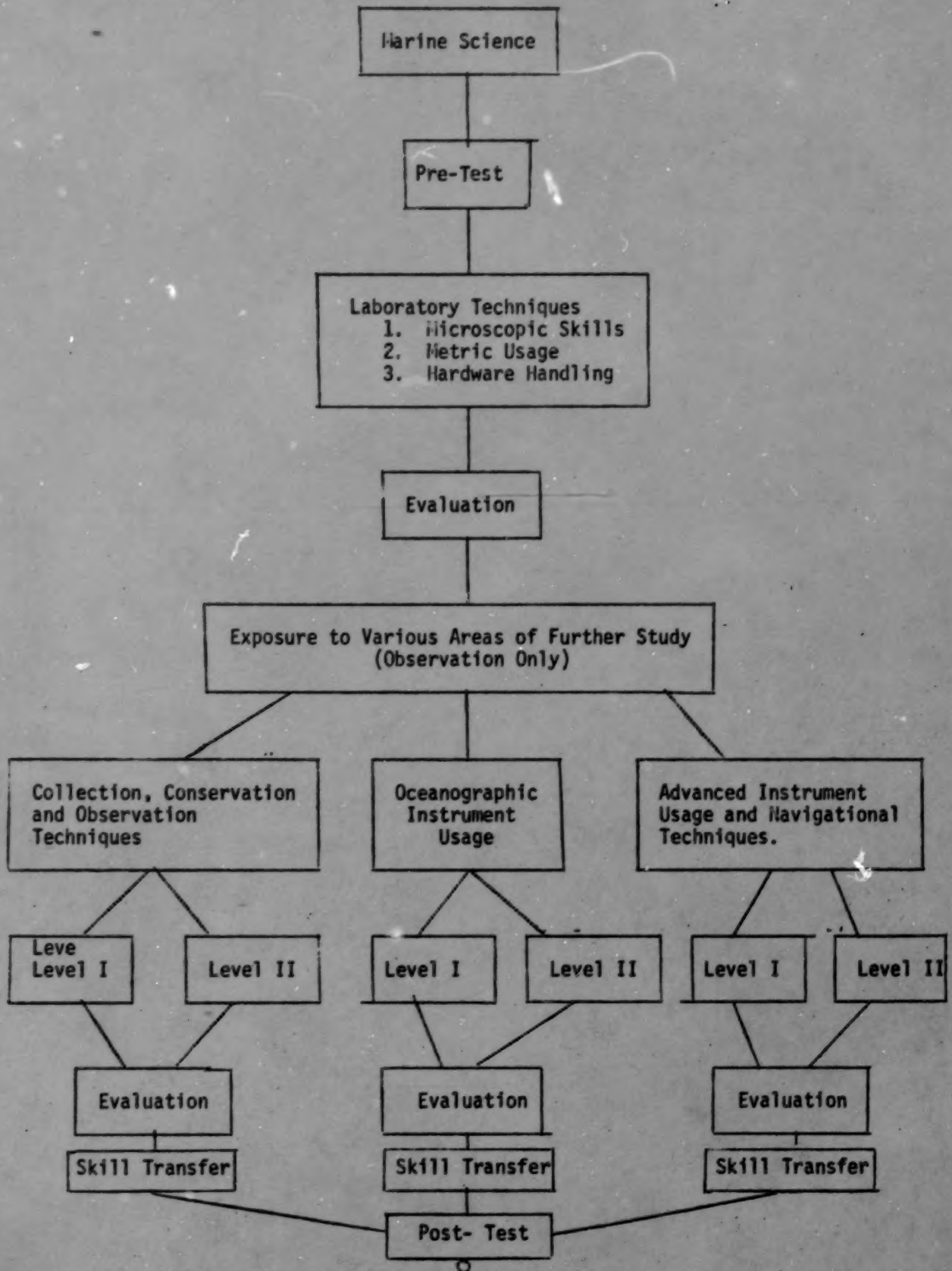
PURPOSE

This program is designed to help students gain experience, knowledge and skills in the area of marine science. This exposure is set up in such a way that the student can not only choose his or her field of interest (from a number of areas), but can also be placed in the appropriate skill level of those areas as a result of the various rating devices employed.

These evaluation tools will help to measure a student's learning progress and degree of development in using higher level thinking skills. Along with the pure academic acquisition of knowledge, the student will be given opportunities and expected to apply the knowledge and skills learned to solving problems in the real world, i.e., commercial research and professional applications.

Brief Course Description

MARINE SCIENCE -- Activities in marine science will include one two hour session a week at the Marine Environmental Center plus a one hour research session at the elementary school. Students will be given introductory lessons in Microscopic Skills, Metric Usage, and Glassware Handling. On completion of these intital activities, two areas will be available to the student for further in-depth study--Collection, Conservation and Observation Techniques and Oceanographic Instrument Usage. If students desire to delve further into the area of marine science, individual projects will be set up by student and instructor using the problem solving approach as a guide for procedure.


Marine Science
Pre-Test
Laboratory Techniques
1. Microscopic Skills
2. Metric Usage
3. Hardware Handling
Evaluation
Exposure to Various Areas of Further Study
(Observation Only)
Collection, Conservation and Observation Techniques
Oceanographic Instrument Usage
Advanced Instrument Usage and Navigational Techniques.
Leve
Level I
Level II
Level I
Level II
Level I
Level II
Evaluation
Evaluation
Evaluation
Skill Transfer
Skill Transfer
Skill Transfer
Post- Test

IDENTIFICATION PROCEDURES

MARINE SCIENCE PRE-POST MEASUREMENT INSTRUCTIONS AND RESULTS INTERPRETATION

INSTRUCTIONS:

1. Test should be given to all fourth, fifth, and sixth grade students, except those who have been identified as slow learners.
2. Forty minutes should be the minimum time allowed for administering the test.
3. Test administrator should explain nature of test, purpose, difficulty factor and encourage students to do their best but not to be frustrated.
4. Test administrator should explain test directions, go over any ambiguous parts and be present to answer any questions about directions, problems, etc.
5. Test administrator should be the same for every testing session, if possible, for consistency.
6. Slide identification of animals and tools is optional and is not absolutely needed for total test validity.
7. Test conditions should be as optimum as possible (lots of room, quiet, etc.).

TEST RESULTS INTERPRETATION:

PRE-TEST ONLY

Overall rating: The main determining factors should come from Sections C, D and E. Sections A, B and F are a back-up factor of rote memory ability and exposure level to give placement level (level 1 or 2). (See key for objective sections.)

SECTION C

1. Marine life is _____. (10 points)

   This should be evaluated on completeness (marine life is any living organism--plant or animal--whose natural habitat is in, or directly related to, salt water), examples (marine life is plankton, sea urchins, fish algae, whales, etc.) or novelty of answer.

2. Give example of three marine animals. _____
   _____
   _____ (9 points)

3. Give examples of three marine plants. _____
   _____
   _____ (9 points)

3. (cont.)

Should be evaluated on: --appropriate answers (marine animals and plants only)
--sophistication of answer (types of animals and plants, not just names)
--value judgment (important or just common animals or plants)

SECTION D This section deals with the student's grasp of plant and animal distribution, predator-prey relationships and knowledge of vocabulary dealing with marine science terms. Grading is strictly objective from the key for Sections A, B, D and F. (1 point per correct answer, 20 total points)

SECTION E This section is dealing with the student's ability to think abstractly, synthesize ideas and develop scientific concepts and experiments on their own. (See individual question comments.)

1. This question should have a point value assignment, as follows, for the inclusion of these in the answer: (5 points total)

   A. Fast digging (1 point)
   B. Hard shell (1 point)
   C. Live in intertidal zone (3 points)

2. Point valve for inclusion of following in the answer: (5 points maximum)

   A. Camouflage or protective coloration (3 points)
   B. Fast swimming (2 points)
   C. Hard shell (2 points)
   D. Spiny body (2 points)
   E. Hide among rocks (2 points)
   F. Live in intertidal zone rocks (2 points)

3. This question is to be graded in three parts:

   1) Constant food -- This can be plankton, small fish or crustaceans for full credit. (2 points)

   2) Constant clean-up -- Crabs, bottom fish, sea cucumbers, bacteria, mud sharks, or starfish for full credit (2 points)

   3) Realistic representation -- Any types of marine plants and animals. The more diverse and numberous, the better. (2 points)

FILL IN:

1. Why is marine water salty? The answer should include something about salt washing down in rivers from land and evaporation and rainfall keeping the salt in balance. (5 points)

2. Temperature -- This answer should show some understanding that a critical temperature range is important for each animal or plant's survival.

FILL IN: (cont.)

3. Salinity -- It should be brought out that each animal or plant has a critical salinity range in which it best lives or survives.

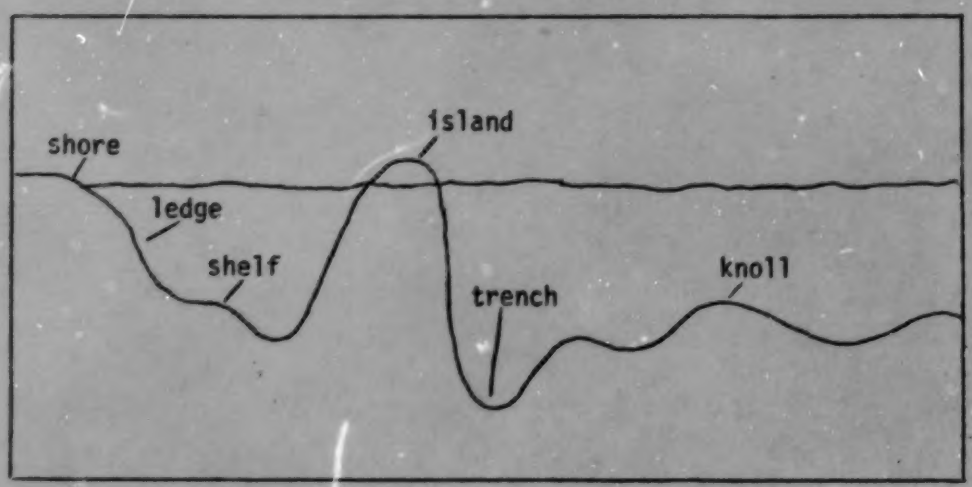
4. Eel grass bed -- Small eels, crabs, sand shrimp, small fish, moon snails, clams and sand worms for full credit. (5 points)

5. Marine plants -- This answer should include something about plants supplying oxygen, protection for small animals, food, and chemical balancing agent. (5 points)

6. Seaweed -- Ice cream, soap, cold cream, Jello, flour, vitamins or pickles could be an acceptable answer. (As many as possible--1 point each, 5 points maximum)

7. Salmon counter -- This answer should include some kind of mechanical or electrical eye counter. Look for originality and detail of description in grading. (10 points)

8. Map -- Judge the map on benthic contours, not animal and plant life. (5 points)
Example:



KEY FOR OBJECTIVE TEST SECTIONS

SECTION A

1. d, h, i
2. a, d, g
3. a, f
4. d
5. c, e
6. d
7. b
8. d, e
9. c
10. d

SECTION B

1. True
2. False
3. True

SECTION D

PART I

f First stage of development

c File-like tongue

g Baby clam or oyster

a Legs, arms, antennae, etc.

e Stomach side

b Back side

PART II

A. 3, 4

B. 1, 2

C. 4, 3

D. 1

E. 2, 1

F. 1, 2

G. 3

H. 4, 3

PART III One answer per blank is sufficient.

Food	Enemy	
2, 3, 10	15	A.
4	15	B.
5	7, 11, 17	C.
6, 5, 10	16, 17	D.
10, 16, 2, 3, 11	8	E.
17, 16, 2, 3	9, 12	F.
16	13	G.
5	17, 11, 17	H.
16, 10	15	I.
4	14	J.

SPECIAL SERVICES
PRE-POST MEASURE FOR MARINE SCIENCE

SECTION A Circle correct answers.

1. From the list of words below, choose three which are related to marine environments (the sea).

a. Woodland
b. Tundra
c. Swamp
d. Estuary
e. River
f. Sand dunes
g. Mountains
h. Salt marsh
i. Tide flats
j. Lake

2. Marine animals need which three of the following to live?

a. Food
b. Warm, dry land
c. Air
d. Water
e. Money
f. Estuary
g. Oxygen
h. Friends

3. The two most common chemicals of sea water are:

a. Sodium
b. Potassium
c. Sulphur
d. Lead
e. Magnesium
f. Chloride

4. The boiling point of water on a centigrade thermometer is:

a. 200^0
b. 212^0
c. 32^0
d. 100^0
e. 0^0
f. 125^0

5. The marine biologist works with: (one answer)

a. Oceanographic instruments
b. Core samples
c. Marine animals
d. Weather data
e. Marine plants

6. Copepods are what kind of animal? (one answer)

a. Phytoplankton
b. Diatoms
c. Dinoflagettes
d. Zooplankton
e. Plants
f. Spiders

7. The food cycle which begins at the base with a producer and has successive consumers (primary, secondary consumers) is called:

a. Food web
b. Food pyramid
c. Food destruction
d. Food production

SECTION A (cont.)

8. Plankton are collected with: (two answers)

a. A hydro wire
b. A beach seine net
c. An otter trainer
d. A fine mesh net
e. A nylon stocking

9. Symbyosis is: (one answer)

a. Eating other animals
b. Making a nest
c. Living in harmony with others
d. Self protection

10. A kind of a defense is: (one answer)

a. Soft skin
b. Fish fin
c. Clam foot
d. A hard shell

SECTION B True-False Section

1. Plankton are any kind of drifting plant or animal life in the sea. _____

2. Fish are not marine animals. _____

3. Most crabs have ten appendages (legs and claws). _____

SECTION C Fill in blanks.

1. Marine life is _____

_____

_____

_____

2. Name three marine animals.

1) _____

2) _____

3) _____

3. Name three marine plants.

1) _____

2) _____

3) _____

SECTION D Match the words on the left with the proper definition in the list on the right. Put the letter from the word list on the left in the blank by the definition on the right.

a. Appendages
b. Dorsal side
c. Radula
d. Spawn
e. Ventral side
f. Larvae
g. Spat

_____ The first stage of development after the egg

_____ A file-like tongue

_____ Baby clam or oyster

_____ Legs, arms, antennae, etc.

_____ Stomach side of animal

_____ Back side of animal

Matching Match the answers on the left with the words on the right. Each answer may be used more than once and each blank may have more than one answer.

If you were going to look at marine animals and plants, what type of beach would you go to find:

Answers

1. Sandy beach
2. Mudflats
3. Rocky beach
4. Gravel beach

A. Seaweed _____
B. Clams _____
C. Shore crabs _____
D. Moon snails _____

E. Oysters _____
F. Shrimp _____
G. Sea anenomes _____
H. Eels _____

Matching Match the answers on the left with the blanks for each animal on the right. Each answer can be used more than once and each blank may have more than once answer.

Answers

1. Anything
2. Oysters
3. Clams
4. Algae
5. Plankton
6. Bacteria
7. Starfish
8. Octopus
9. Man
10. Decayed material
11. Moon snail
12. Large fish
13. Killer whales
14. Otters
15. Nothing
16. Small fish
17. Crab

	My Favorite Food is:	My Horst Enemy Is:
A. Starfish	_____	_____
B. Chiton	_____	_____
C. Clam	_____	_____
D. Sea cucumber	_____	_____
E. Crab	_____	_____
F. Octopus	_____	_____
G. Salmon	_____	_____
H. Oyster	_____	_____
I. Sea anenome	_____	_____
J. Sea urchin	_____	_____

SECTION C

1. If you were a clam how would you get away from your enemies? (What kind of things would you use for protection?)

2. If you were an animal that lived on a rocky coastline, how would you keep from being eaten?

3. If you were going to set up a mini-ocean that had all the plants and animals in it to make it work by itself, what kind of things (plants, animals and equipment) would you need?

F[illegible]

1. How does marine water get salty?

2. What does temperature of the water have to do with where marine plants and animals live?

3. What can you tell about the marine plants and animals in an area by how salty the water is?

SECTION E (continued)

4. What kind of animals could you expect to find around an eel grass bed?

5. Why are marine plants important to the sea?

6. Name some things that are made with, or that you could make with, seaweed?

7. You have been given the job of counting the number of salmon going up a fish ladder on their way to spawn. What kind of machine or tool could you invent to make your job easier?

8. Draw a map and label the parts of what you think the bottom of the ocean looks like.

Map

SECTION F Slide Presentation

Write in the blanks the names of the animals you see on the screen.

Animals

1. _____ 8. _____
2. _____ 9. _____
3. _____ 10. _____
4. _____ 11. _____
5. _____ 12. _____
6. _____ 13. _____
7. _____

Equipment

1. _____ 6. _____
2. _____ 7. _____
3. _____ 8. _____
4. _____ 9. _____
5. _____

SECTION G Answer yes or no.

1. Do you live on, or within walking distance of, the beach? _____
2. Is your father a commercial fisherman? _____ A diver? _____
   Does he have a boat? _____
3. Do you go to the beach at least once a week? _____
4. Have you been to the Marine Environmental Center? _____

SPECIAL SERVICES
PRE-POST MEASURE FOR MARINE SCIENCE

SECTION A Fill in blanks.

1. Marine life is _____

_____

_____

_____

2. If you were an animal that lived on a rocky coastline, how would you keep from being eaten?

_____

_____

_____

3. If you were going to set up a mini-ocean that had all the plants and animals in it to make it work by itself, what kind of things (plants, animals and equipment) would you need?

_____

_____

_____

Fill in.

4. How does marine water get salty? _____

_____

_____

5. What is plankton? _____

_____

Why is it important? _____

_____

6. Why are marine plants important to the sea? _____

_____

_____

SECTION A (continued)

7. You have been given the job of counting the number of salmon going up a fish ladder on their way to spawn. What kind of machine or tool could you invent to make your job easier?

_____

_____

_____

_____

SECTION B Hatching

1. Below is a list of different types of beaches.

(1) Sandy beach
(2) Mudflats
(3) Rocky beach
(4) Gravel beach

Beside each marine plant and animal listed below, write the type of beach where you would find that plant or animal (you can use the numbers, if you wish).

A. Seaweed	_____	E. Oysters	_____
B. Clams	_____	F. Shrimp	_____
C. Shore crabs	_____	G. Sea anenomes	_____
D. Moon snails	_____	H. Eels	_____

2. Below is a list of marine plants and animals. - Write the favorite food of each one and its worst enemy on the blank provided at the right. Choose your answers from the list on the left (you can use numbers, if you wish).

Answers		My Favorite Food is:	My Worst Enemy is:
1. Anything			
2. Oysters	A. Starfish	_____	_____
3. Clams			
4. Algae	B. Chiton	_____	_____
5. Plankton			
6. Bacteria	C. Clam	_____	_____
7. Starfish			
8. Octopus	D. Sea cucumber	_____	_____
9. Man			
10. Decayed material	E. Crab	_____	_____
11. Moon snail			
12. Large fish	F. Octopus	_____	_____
13. Killer whales			
14. Otters	G. Salmon	_____	_____
15. Nothing			
16. Small fish	H. Oyster	_____	_____
17. Crab			
	I. Sea anenome	_____	_____
	J. Sea urchin	_____	_____

SECTION B (continued)

3. Match the words on the left with the proper definition in the list of the right. Put the letter from the word list on the left in the blank by the definition on the right.

a. Appendages	_____	The first stage of development after the egg
b. Dorsal side		
c. Radula	_____	A file-like tongue
d. Spawn		
e. Ventral side	_____	Baby clam or oyster
f. Larvae		
g. Spat	_____	Legs, arms, antennae, etc.
	_____	Stomach side of animal
	_____	Back side of animal

SCORING KEY FOR MARINE SCIENCE EVALUATION TOOL

SECTION A - SUBJECTIVE (Fill in blanks)

1. Marine life is:

   5 point answers -- organisms living in salt water; plants and animals living in salt water; a list of five or more marine animals or plants

   3 point answers -- animals living in marine or salt water; a list of two or more marine animals or plants

2. If you were an animal that lived on a rocky coastline, how would you keep from being eaten?

   5 point answers (2 responses necessary for 5 points) -- hide in among the rocks if I was small enough; hide under the kelp or seaweed; protective coloration (camouflage); hard shell

   3 point answers -- any single answer above

3. If you were going to set up a mini-ocean that had all the plants and animals in it to make it work by itself, what kinds of things (plants, animals and equipment) would you need?

   5 point answer -- answer should include all of the following categories (minus one point per deleted category)

   1. air pump or algae (to supply oxygen)
   2. plankton (to feed the filter feeders)
   3. scavengers (shrimp, crabs and sea cucumbers)
   4. predators (fish, eels, starfish, snails)
   5. filter feeders (clams, oysters, geoducks, tube worms, mussels, barnacles)

4. How does marine water get salty?

   5 point answers -- from the minerals washed into the sea by rivers; erosion from rainfall that is carried to the sea by rivers and fresh water is evaporate off; during the sea formation the minerals in the ocean basins dissolved to mak the water salty

   2 point answers -- streams rub salt off rocks; dirt on the land is carried by streams; water evaporates off of the sea leaving the salt

5a. What is plankton?

   5 point answers -- any floating, drifting or weakly swimming animal or plant found in the sea; any organism that can't control where the sea is taking it; small plants and animals that float or drift with the tides and currents of the sea.

   3 points answers -- small marine animals found in the water; small life in the water; little animals floating in water.

5b. Why is it important?

5 point answers -- many animals depend on plankton for food (whales, fish, clams, mussels, barnacles, oysters); many animals have larva that are plankton for part of their life cycle; plant plankton is the main way that food is produced form sunlight for the marine animals; it is the base of the food chain

3 point answers -- it is important for fish food; for animals to eat; important as a future food source for people

6. Why are marine plants important to the sea?

5 point answers (must contain two statements) -- they give off or supply oxygen for the animals and are food for some types of animals; they give a hiding place for small animals, a place to get food for other animals and a place for other plants to attach themselves

3 point answers -- any single answer above; they keep a balance in the sea; they protect animals from waves, drying out, etc.

7. You have been given the job of counting the number of salmon going up a fish ladder on their way to spawn. What kind of machine or tool could you invent to make you job easier?

5 point answers --

1. 2 points for some type of clever counter (electric eye with digital readout, mechanical counter, trap-type counter, etc.)
2. 1 point for diagram of apparatus
3. 2 points for explanation of how the system works

SECTION B - OBJECTIVE
One point per correct response

1. Need to only have one of the correct responses out of the possible for the point

A.	1 or 3 or 4	E.	2 or 3 or 4
B.	1 or 2 or 4	F.	1 or 2
C.	3 or 4	G.	3
D.	1 or 2	H.	1, 3

2. Same as number 1 (one point for each category)

	Favorite Food	Worst Enemy
A.	2,3	9, 15
B.	4	15
C.	5	7
D.	5, 6, 10	15
E.	10	8
F.	17	12, 13
G.	5, 16	13
H.	5	7
I.	5, 16	15
J.	4, 10	14

3. One point per correct response

F	first stage of development after the egg
C	a file-like tongue
G	baby clam or oyster
A	legs, arms, antennae, etc.
E	stomach side of animal
B	back-side of animal

TEACHER CHECKLIST OF OBSERVED TRAITS

Does the student show:	Yes	No
1. High level of interest in marine science?	___	___
2. High aptitude in:		
1) identifying skills?	___	___
2) collecting skills?	___	___
3) reasoning skills?	___	___
4) creative thinking?	___	___
5) spontaneity of original thoughts?	___	___
6) synthesis of ideas?	___	___
3. High level of interest in living things?	___	___
4. High level of innate curiosity?	___	___
5. High level of motivation in dealing with self-interest things?	___	___
6. High achievement in classwork dealing with math?	___	___
with science?	___	___
7. Interest in extra curricular science related activities?	___	___
projects?	___	___
science fairs?	___	___
other experiences?	___	___
8. Any behavioral or disciplinary problems?	___	___

Explain: _____

_____

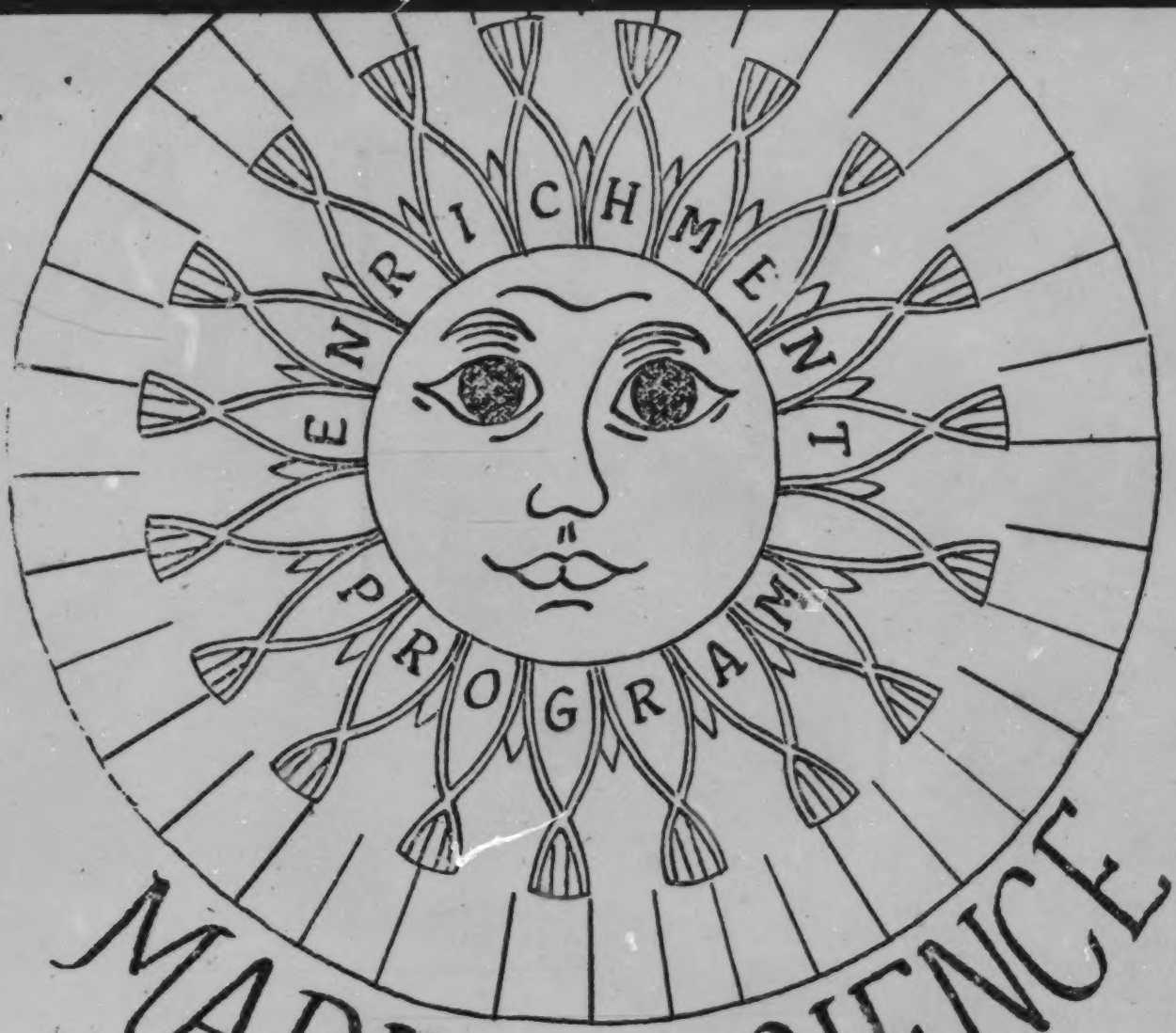
_____

_____

_____

_____

_____



BASIC MARINE SCIENCE LABORATORY TECHNIQUES

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Developed by
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Under ESEA Title III
North Kitsap School District #400
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BASIC MARINE SCIENCE LABORATORY TECHNIQUES

LAB TECHNIQUES PACKET

THE MICROSCOPE

MATERIALS:

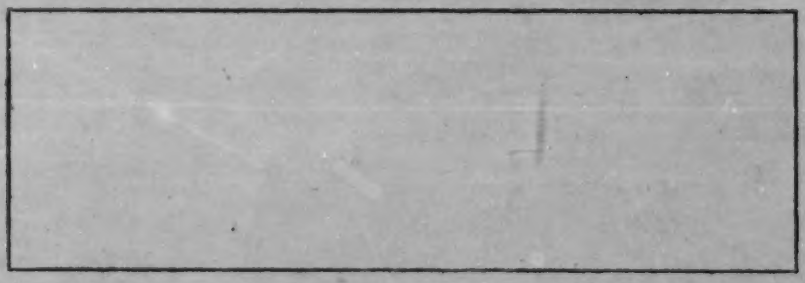
1. 1 stereomicroscope
2. 1 monocular microscope
3. Research phase microscope
4. 1 Petrie dish
5. 1 eye dropper
6. Plankton sample
7. 2 glass microscope slides
8. 2 glass microscope coverslips
9. 1 human hair
10. Counting card
11. 10 ml. pipette

TASK: Successfully complete four of the five projects with a lab partner before going to the next packet.

1. Get materials #1 and 9. Put human hair under the scope and practice focusing under, on and above the hair, using the focus knob on the scope. Using the light control knob(s) find which setting shows the hair the best (upper, lower or both)?

   _____

2. Get materials # 1, 4, 5 and 6.
   Get an eyedropper full of plankton sample and put five drop puddles in various places on the Petrie dish. With the Petrie dish on the stereoscope examine what is in the sample. Use different lighting and focusing to get the most complete and clear image. Draw one animal, that you see in the sample, as clearly and as detailed as you can.



3. Get materials # 2, 7, 8, and 9.
   Set up microscope with lowest lens power (yellow) and light on. Place hair on slide and put coverslip over it. Put slide under the lens, focus, and use the diaphram lever to control the light source. Observe and sketch what you see under the microscope. Turn the objective to the next highest power (blue), adjust the diaphram to the best light amount and draw a detailed picture of what you see. Turn the objective to the highest power (red) and repeat the previous step.

(See next page.)

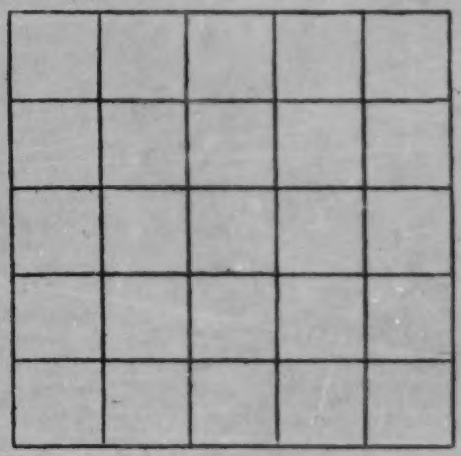
THE MICROSCOPE (continued)

3. (continued)

(yellow)	(blue)	(red)

4. Get materials # 1, 4, 6, 10 and 11.

Using the pipette, get a 10 ml. sample of the plankton population in the beaker, and transfer it to the Petrie dish. Swirl the dish so that the entire bottom surface is wet. Using the stereomicroscope, place the counting grid on the stage, then place the Petrie dish exactly on top of it. Count the total number of plankton in ten squares. There are 250 squares on the grid so you need to multiply by 25 to get the total number in the dish. Fill in the number of plankton in each square as you go, then add them up, multiply and put your final answer in the blank.



Total answer _____

5. You have the job of being an illustrator for a book on plankton. Fill in the blanks telling what equipment would be best to use, how you would set it up to give the best image, and what adjustments you would make while you are observing and drawing. Carry out the procedure and draw the best, most detailed picture you can.

Equipment (What do you need?)

1.

2.

3.

4.

THE MICROSCOPE (continued)

5. (Continued)

Equipment (cont.)

5.

6.

7.

8.

9.

10.

Procedure (How would you set up for viewing the plankton?)

Adjustments (What will you do while you are drawing to keep the best image showing?)

Picture

Title III

STUDENT COPY

LAB TECHNIQUES PACKET

METRIC SYSTEM EXERCISES

The Metric System of weights and measurements is used in almost every country of the world except the United States. It is also used by all scientists and people working with science because it is a universal system and is much easier to use once you are familiar with it.

The main advantage to the metric system is that all units are interrelated and they are all base ten. Base ten is like our money system (10 pennies equal 1 dime, 10 dimes equal 1 dollar is the same as 10 millimeters equal 1 centimeter and 100 centimerers equal 1 meter.) Below is a chart with all the prefixes, units and their meanings.

English and Metric Equivalents

	English	Metric
Length	foot	meter
Volume	gallon	liter
Mass	pound	gram

Metric Prefixes

*Mega-	M	10^6	1,000,000	million
*kilo-	k	10^3	1,000	thousand
hecto-	h	10^2	100	hundred
deca-	da	10^1	10	ten
-	-	10^0	1	-
*deci-	d	10^{-1}	.1	one tenth
*centi-	c	10^{-2}	.01	one hundredth
*milli-	m	10^{-3}	.001	one thousandth
*micro-	u	10^{-6}	.000001	one millionth
nano-	n	10^{-9}	.000000001	one billionth
pico-	p	10^{-12}	.000000000001	one trillionth

DIRECTIONS: With your partner, successfully complete 4 out of 5 exercises before you go on to the next packet.

MATERIALS:

1. Gram single pan balance
2. Wooden meter stick
3. 450 ml graduated cylinder
4. Large beaker
5. Volume displacement tank
6. Coin (penny)

MATERIALS: (cont.)

7. Large brass or heavy metal chunk
8. 2 liter graduated cylinder
9. Sea cucumber
10. 2 pound lead diving weight
11. Wall to stand against
12. One large tank (aquarium)

EXERCISES:

1. Get materials # 2 and 11. Find your height and your partners height in centimeters to the nearest 1/10 of a centimeter. Record your answers.

   Your height _____cm.

   Your partner's height _____cm.

2. Get materials #1,6, and 7. Find the weight of the penny and the metal to the nearest 1/10 of a gram. Make sure the scales are on zero before starting. Weigh each object three times to make sure of your accuracy.

PENNY	METAL
A._____ gm.	A._____gm.
B._____ gm.	B._____gm.
C._____ gm.	C._____gm.

3. Get materials # 8 and 9. Find the volume displacement of the sea cucumber by placing it in the 2 liter graduated cylinder after you have put 500 ml. of water in it. Read the new volume from the bottom of the meniscus (the ⌣ line of water on the top). Make both readings very accurately. Subtract the 500 ml. reading from the final reading for your final answer. Repeat three times at five minute intervals. If the answers are different, explain why.

A. _____ ml.	B. _____ ml.	C. _____ml.
- 500 ml.	-500 ml.	- 500 ml.

Explain any differences: _____

_____

_____

_____

EXERCISES: (cont.)

4. Get materials # 2 and 12. Find the volume of the tank in cubic meters using the meter stick. (Note: Volume = length x width x depth). Make all your measurements and calculations accurately. Give your answer to the nearest 1/10 of a meter.
If the tank is filled with sea water, how much weight will the water weigh (sea water weighs 2,200 lbs. per cubic meter) in grams?

Volume - Length _____ Total
Width _____ Volume _____
Depth _____

Weight of water _____

5. Get materials # 1,3,4,5 and 10. Fill the volume displacement tank up to the bottom of the outlet. Weigh the beaker dry. Weigh the lead dry. Put the beaker under the outlet, place the weight in the tank and let the water run out until it stabilizes. Weigh the beaker and water. Measure how many millimeters it is. If the weight of the water and lead are not the same, explain why

Weight of lead _____ Volume _____
Weight of beaker _____
Weight of water _____

Explain the difference: _____

_____

_____

_____

_____

LAB TECHNIQUES PACKET

LAB GLASSWARE AND EQUIPMENT HANDLING METHODS

All laboratory gear should be handled with the utmost care because it is fragile and expensive.

--Glassware should always be clean and dry before starting an experiment.
--Always clean and put away your equipment after you finish each session.
--Make sure that all metal tools and containers are rinsed in tap water and dried after using.
--All chemicals and supplies should be put away before leaving.

DIRECTIONS:

With your partner, complete three out of the three exercises correctly. Make sure the instructor checks your final results.

MATERIALS:

1. Gram single pan balance
2. Sodium chloride sample
3. Tap water
4. 400 ml beaker
5. 400 ml flask
6. Centigrade thermometer
7. 50 ml graduated cylinder
8. 450 ml graduated cylinder
9. Hydrometer and density graphs
10. Thermister temperature gauge
11. 1 ml pipette
12. 10 ml pipette
13. Salt water

EXERCISES:

1. Get materials #1, 2, 3, 4, 7, 8 and 9.

Determine the weight of the beaker on the balance. While the beaker is still on the balance, add exactly 5.5 gms. of sodium chloride (salt) to the beaker. Add exactly 300 ml of tap water using the 50 ml graduated cylinder. What is the final weight? Mix the salt and water together and pour into the 450 ml graduated cylinder. Using the density charts and the hydrometer, measure the salinity of the salt water you just mixed up.

Weight of beaker _____ gm.

Weight of salt 5.5 gm.

Total weight _____ gm.

Hydrometer reading _____

Actual density _____

Corrected salinity _____‰ (parts per million)

LAB GLASSWARE AND EQUIPMENT (cont.)

2. Get materials #7, 11, 12 and 13.

Using the 10 ml pipette, fill the 50 ml graduated cylinder (5 pipettes full) with salt water. Is the amount exactly 50 ml? If it isn't, why not? Using the 1 ml pipette, fill the graduated dylinder to the 10 ml mark. Does the meniscus line up exactly with the 10 ml mark? If not, what is the reason for the difference? Both partners should use both pipettes.

Your measurement after 5, 10 ml pipettes _____ ml

Is it exactly 50 ml? _____

Why? _____

_____

_____

Your measurement after 10, 1 ml pipettes _____ ml

Is it exactly 10 ml? _____

Why? _____

_____

_____

Are your partner's answers the same? _____

3. Get materials #6 and 10.

Measure the temperature of all the sea tables in the lab, using the centigrade thermometer. Do the same thing using the thermister gauge. Have your partner do the same.

Thermometer Readings	Thermister Readings
1. _____ ^{o}C	1. _____ ^{o}C
2. _____ ^{o}C	2. _____ ^{o}C
3. _____ ^{o}C	3. _____ ^{o}C
4. _____ ^{o}C	4. _____ ^{o}C
5. _____ ^{o}C	5. _____ ^{o}C
6. _____ ^{o}C	6. _____ ^{o}C
7. _____ ^{o}C	7. _____ ^{o}C
8. _____ ^{o}C	8. _____ ^{o}C
9. _____ ^{o}C	9. _____ ^{o}C

LAB GLASSWARE AND EQUIPMENT (cont.)

3. (Continued)

Thermometer Readings (cont.)	Thermister Readings (cont.)
10. _____ °C	10. _____ °C
11. _____ °C	11. _____ °C
12. _____ °C	12. _____ °C
13. _____ °C	13. _____ °C
14. _____ °C	14. _____ °C
15. _____ °C	15. _____ °C
16. _____ °C	16. _____ °C
17. _____ °C	17. _____ °C

Is there a difference between the temperature of the sea tables? _____

Why? _____

_____

_____

Is there a difference between the readings of the thermometer and the thermister?

_____

Why? _____

_____

_____

DRAWING ACTIVITY -- No. 1

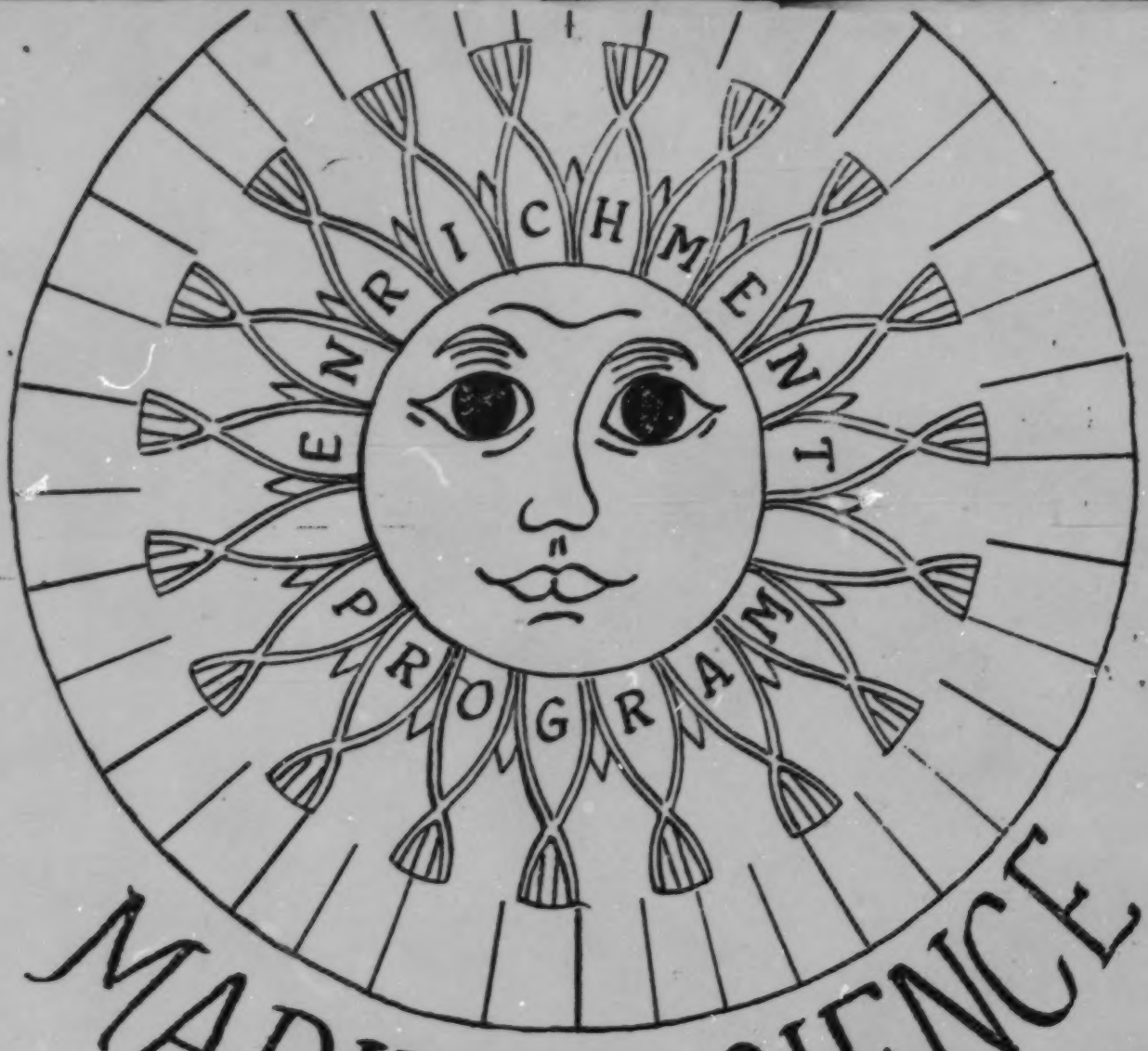
Materials:

1. Drawing paper (get from instructor)
2. Pencil
3. Animal (provided by instructor)
4. Glass petri dish

Directions:

1. With the animal provided, draw in complete detail and label parts. Labeling should be in horizontal fashion.

2. Supply a minimum of three (3) facts on your animal. Example: Where it is found. What it eats. Etc.



MARINE SCIENCE

COLLECTION, CONSERVATION, AND OBSERVATION TECHNIQUES

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Developed by
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COLLECTION AND OBSERVATION TECHNIQUES

FOR PLANTS AND ANIMALS

NORTH KITSAP MARINE ENVIRONMENTAL CENTER
E.S.E.A. TITLE III

IDENTIFYING BY USE OF "KEYS"

A classification key is based on the logic of a correct choice. To be sure that you are "working" the key right, take a coin from your pocket and work this key to U.S. Coins in Common Usage.

You will notice that under each number there are two choices; if your object does not satisfy one, it must satisfy the other.

Key to U.S. Coints in Common Usage

1. Silver colored.....2
   Not silver colored; copper colored.....Penny

2. Smaller than penny.....Dime
   Larger than penny.....3

3. With a picture of a bird.....5
   Not with a bird, but with a bison ("buffalo"), a building or a bell.....4

4. With a bell (and B. Franklin).....Half-dollar
   With a "buffalo" or building.....Nickel

5. Bird in flying position.....Quarter
   Bird as if standing on branch with wings outstretched or clutching arrows in one claw.....6

6. With bust of George Washington on other side.....Quarter
   Without bust of G. Washington.....7

7. With eagle as on National Seal.....Half-dollar
   With eagle on side view, woman's figure on other side.....Half-dollar

CLASSIFICATION OF SALT WATER ANIMALS COMMON TO PUGET SOUND

1. Phylum Porifera

Characteristics:	Examples:
1) Soft and spongy 2) Many, many tiny individuals making up a colony	Sponges

2. Phylum Coelenterata

Characterisitcs:	Examples:
1) Single, hollow, central cavity 2) Tentacles around the mouth 3) Round in shape 4) Alternation of generations	Sea anemone

3. Phylum Ctenopora

Characteristics:	Examples:
1) Round, clear, jelly like 2) Eight rows of cilia	Combjelly-tetenophore

4. Phylum Platy Helmintiaes

Characteristics:	Examples:
1) Flat, leaf like 2) Biluterally symmetrical	Flatworms

5. Phylum Rhynococoela-Hemertine worms

Characteristics:	Examples:
1) Slender, cylindrical 2) Are not segmented 3) May be very long 4) Probosics (snout) can be moved in and out	Ribbon worms

6. Phylum Ectoprocta-Bryozoans

Characteristics:	Examples:
1) Hard, rough spots	Existing on rocks Seaweed and animals

7. Phylum Annelida

Characterisitcs:	Examples:
1) Segmented worms 2) With or without short paddle like arms 3) Well developed heads 4) May live in hard or papery tubes	Tubeworms

Classification of Salt Water Animals Common to Puget Sound (continued)

8. Phylum Arthropoda-Class Crustacea

Characteristics:	Examples:
1) Hard, chitinous exoskeleton (outer coverings)	Crabs--all kinds
2) Paired, jointed appendages on some of the segments of the body	
3) Two pairs of antenna	
4) Gill breathing	
5) Head, thorax and abdomen	

9. Phylum Molluska

Characteristics:	Examples:
1) Soft body	
2) No internal skeleton--usually a hard shell outside	Clam
3) Ventral muscular foot for locomotion	

10. Phylum Echinodermata

Characteristics:	Examples:
1) Spiny skeleton of plates which usually covers the body	Starfish
2) The adults are round and are usually in five parts	
3) Tube feet	
4) Power of regeneration	

11. Phylum Chordata

Characteristics:	Examples:
1) Hollow dorsal nerve-cord	
2) Voto chord	Tunicates (sea squirts)
3) Gill slits	Salmon
4) Bony gills	
5) Jaws	
6) Fins	
7) Bony skeleton	
8) Scales in skin	
9) Cold-blooded	

COLLECTION AND OBSERVATION TECHNIQUES FOR PLANTS AND ANIMALS

ANIMALS

Materials:

1. Reference reading materials package
2. Key to common marine animals of Puget Sound
3. One copy of "Common Animals of Puget Sound" by Kozloff
4. Magnifying glass
5. Plastic pan
6. Timer or watch
7. Disecting kit
8. Fiber tray
9. Paper towels

Directions: Read the reference reading materials packet before starting any exercises. Do exercise No. 1 and then any two of the three remaining exercises before going on to the plant packet.

I. Using the "Key to Common Marine Animals", give the common name and draw a picture of ten of the animals that your instructor has set up for you. Using the textbook "Sea Shore Life of Puget Sound:, give the scientific name of each of the animals. What phylum does each animal belong to? Give at least one reason why.

1. Common name _____
   Scientific name _____
   Phylum _____
   Why? _____

2. Common name _____
   Scientific name _____
   Phylum _____
   Why? _____

3. Common name _____
   Scientific name _____
   Phylum _____
   Why? _____

4. Common name _____
   Scientific name _____
   Phylum _____
   Why? _____

5. Common name _____
   Scientific name _____
   Phylum _____
   Why? _____

6. Common name _____
   Scientific name _____
   Phylum _____
   Why? _____

7. Common name _____
   Scientific name _____
   Phylum _____
   Why? _____

8. Common name _____
   Scientific name _____
   Phylum _____
   Why? _____

9. Common name _____
   Scientific name _____
   Phylum _____
   Why? _____

10. Common name _____
    Scientific name _____
    Phylum _____
    Why? _____

II. Get materials numbers 4,5,6. Choose an animal to observe it's behavior during a 15 minute period. Be sure to choose one that is easy to observe. (Example: hermit crabs, sea cucumber, perch, sea urchin, starfish) As you are observing the animal, answer the following questions.

1. Does the animal show territoriality (does it defend an area against other animals like itself)? _____

   _____

   How can you tell? _____

   _____

2. Is it feeding? _____

How does it feed? _____

_____

Is there any special pattern to it's feeding? _____

What is it? _____

_____

3. Does the animal move? _____

How many different ways does it move? _____

_____

What parts of it's body does it use to move? _____

_____

4. How does the animal sense the environment around him (What body parts does it use)? _____

_____

How many different senses does it have (touch, smell,sight, sound,taste) ? _____

_____

How can you tell? _____

_____

If you were that animal what kinds of things would you use to escape your predators? _____

_____

_____

5. If you were that animal, what additional defenses, movements and senses would you have to keep from being eaten? _____

_____

_____

III. Get materials #2, 3, 4, 5 and a meter stick. During a good low tide, go under the dock and observe a piling close to the water. Observe all the animals on the piling very closely and do the following:

A. Using the keys and guide book, list the common names of all the animals you can find living on that piling.

1. 11.
2. 12.
3. 13.
4. 14.
5. 15.
6. 16.
7. 17.
8. 18.
9. 19.
10. 20.

B. Mark off and measure the vertical zone on the piling that each animal is living in. Measure the width of the zone and how far the bottom of that zone is from the sand.

	WIDTH	HEIGHT FROM SAND
1.	_____	_____
2.	_____	_____
3.	_____	_____
4.	_____	_____
5.	_____	_____
6.	_____	_____
7.	_____	_____
8.	_____	_____
9.	_____	_____
10.	_____	_____
11.	_____	_____

III.

B. (Cont.)

	WIDTH	HEIGHT FROM SAND
12.	_____	_____
13.	_____	_____
14.	_____	_____
15.	_____	_____
16.	_____	_____
17.	_____	_____
18.	_____	_____
19.	_____	_____
20.	_____	_____

C. Give at least two reasons why the animal zones can't be switched. EX: Why can't a Barnacle trade places with a Sea Anenome?)

_____

_____

_____

D. Why do you find these animals attached to or clinging to the piling instead of some other habitat? _____

_____

_____

_____

CLAMS - THE INSIDE STORY

PROCEDURE:

Part A: General Features

1. Examine your specimen carefully. Clams are entirely or almost entirely enclosed in a shell called the EXOSKELETON. Because a clam shell has two halves or VALVES, clams are called BIVALVES. Name some types of mollusks which have only one valve.

2. The region of the clam where the two valves come together is called the DORSAL, the opposite side of the shell, where it opens, is the VENTRAL region. On the dorsal side is a swollen projection which is called the UMBO. This is usually the thickest part of the clam.

   The clam also has an ANTERIOR end and a POSTERIOR end. The umbo is usually closest to the anterior end. Most clams have two tubes or SIPHONS which project from the posterior end. In the space below, label the various parts of a clam. (Make a drawing)

   exoskeleton
   dorsal side
   ventral side
   posterior end
   anterior end
   umbo
   valve

Part B: Exoskeleton

1. Examine the dorsal region of your shell and note that the two valves are joined by a tough elastic band. This band is called the HINGE LIGAMENT. This is the ligament a clam uses to <u>open</u> his shell. It does not hold a shell closed, and this is why an empty clam shell is usually found in an open position.

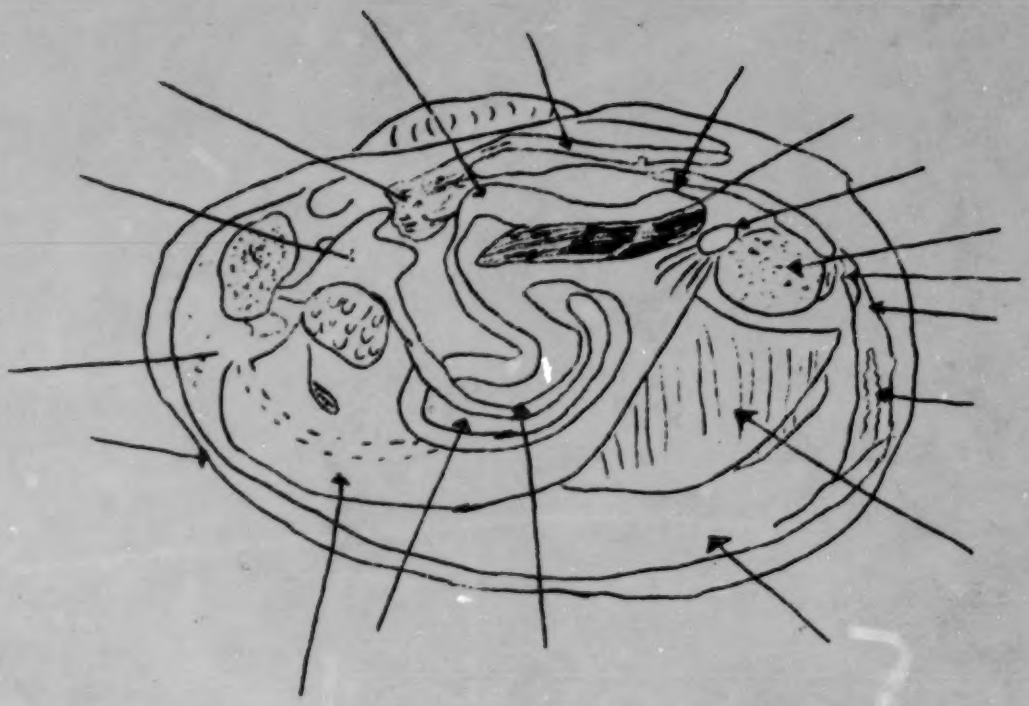
   The umbo is the oldest part of the shell. Spreading out from the umbo are curved lines called LINES OF GROWTH. As time goes by new lines of growth are added in the ventral region.

2. Now examine the inside of the shell. Notice that it is smooth and pearly looking except for marks or IMPRESSIONS where various parts of the animal were attached to it. One of these marks is the PALLIAL LINE which runs along the ventral part of the shell.

   At the posterior end of the shell, where the siphon tubes are usually attached, the line curves inward and is called the PALLIAL SINUS. The pallial line ends on each end of the shell in large oval impressions called SCARS where the powerful muscles were attached. These were the muscles the clam used to close the valves.

   Close to the hinge are little projections called TEETH. Is the arrangement of teeth the same on each valve? Why?

In the diagram below, label all the parts marked with arrows.



Part C: Mantle and Siphons

1. To open your clam carefully, cut through the adductor muscle by inserting a scalpel at a slant through the posterior end. Once you have cut this muscle, gently run your scalpel along the ventral region close to the shell to free the clam from one valve, cut through the other adductor muscle, and the shell will open. Leave the body in one valve.

2. Notice that the body of the clam lies inside of a thin membrane. This membrane is called the MANTLE and it is the part of the animal that secretes the shell material. A clam shell not only grows along the ventral side, but it also grows thicker with age. Find the line on the mantle where it attached to the pallial line on the shell.

3. At the posterior end of the mantle are the SIPHONS through which the clam takes in and lets out water. The dorsal siphon (usually the smallest) is the EXCURRENT SIPHON, and the other larger opening is the INCURRENT SIPHON. If you look carefully at the opening of the incurrent siphon you will see little PAPILLAE which act as senses.

Part D: Main Body Organs

1. Cut away the loose parts of the mantle. The large flattened mass near the ventral side that is shaped like a keel is the FOOT. It is very muscular as it is the main way a clam is able to move about.

2. The internal organs are inside the VISCERAL MASS on the dorsal part of the foot. The two thin flaps which partly cover the visceral mass are the GILLS. The gills are marked by stripes which run up and down. These stripes are called WATER TUBES and are used in respiration.

3. Near the anterior end of the clam are two little flaps, the LABIAL PALPS which open to expose the MOUTH, which is just a slit. Little hairs or CILLIA collect microscopic food material and direct it into the mouth.

4. Above the gills is a thin membrane which encloses a large cavity. Carefully remove one thin wall of the cavity. You will see a tube passing through the cavity. The central part is the HEART and on each side is an AORTA.

5. On the floor of the cavity is a brownish structure called the NEPHRIDIUM. The nephridium is part of the excretory system.

Clams - The Inside Story (cont.)

Part D: (cont.)

6. Go back to step 2 and the VISCERAL MASS. The stomach and intestines are imbedded in this mass, so what you need to do is cut through it dorsally to ventrally to expose the various parts. The large cavity is the STOMACH and the loop is the INTESTINE. You may be able to find two greenish glands near the stomach. These are the DIGESTIVE GLANDS.

7. The GONADS are the reproductive organs and are the yellowish branched material in the visceral mass.

IV. Get materials #4, 7, 8 and 9. Also get a clam and a small sculpin from your Lab instructor. NOTE: These animals are preserved in formalin (a very powerful poison) so be sure and wash your hands after you finish.

You are to disect each animal so that you can identify the various parts of the animals shown in the diagrams. The best disecting tools, that do the least damage to the tissues, are a pair of sharp scissors and your fingers. Remember, you are scientists, not butchers. After you have found all the structures and organs on each animal, answer the following questions.

A. What kind of structures does each animal use for protection?

Clam: _____

_____

Sculpin: _____

_____

B. What kind of structures does each animal use for escape from predators?

Clam: _____

_____

Sculpin: _____

_____

C. What organs and structures does each animal use for gathering, digesting and absorbing food?

Clam: _____

_____

Sculpin: _____

_____

D. Find the gill structure for each animal. Draw a picture of the location of each.

CLAM	SCULPIN

Why are they different? _____

_____

_____

V. Get materials #2, 3, 4 and 5 and four marking stakes. Your task is to mark off a one square meter area on a mud, sand, gravel and rocky beach at the same height on the tide line. Compare the animal life that you find under or on the surface of the four beach types.

A. List the common names of the animals you find.

MUD:	1.	6.
	2.	7.
	3.	8.
	4.	9.
	5.	10.
SAND:	1.	6.
	2.	7.
	3.	8.
	4.	9.
	5.	10.

V. A. (cont.)

GRAVEL:	1.	6.
	2.	7.
	3.	8.
	4.	9.
	5.	10.
ROCK:	1.	6.
	2.	7.
	3.	8.
	4.	9.
	5.	10.

B. Why aren't the same animal types found on all the beaches?

_____

_____

_____

C. Give at least one example of how an animal has adapted its body to best survive in its environment.

1. Sand environment _____

_____

2. Rocky environment _____

_____

3. Mud environment _____

_____

4. Gravel environment _____

_____

DRAWING ACTIVITY -- No. 2

Materials:

1. Paper (provided)
2. Pencil
3. Animal (provided)
4. Glass petri dish or tray

Directions:

1. With the animal provided, draw in complete detail two (2) angles of your animal.
2. Label parts in horizontal fashion.
3. Supply four (4) interesting facts (What does this animal do to protect himself? What characteristics help this animal live in its tidal zone? Etc.).

KEY TO IDENTIFICATION OF SOME COMMON MARINE ALGAE

1. Plant green. (2)

1. Color of plant brown or red. (5)

    2. Plant grass-like (with roots). ZOSTRA (just out of tital zone)

    2. Plant not grass-like (3)

3. Plant grows in tufts and looks like green sea hair in the water. Usually in rock pools. SEA HAIR (CLADOPHORA).

3. Plant not hair like. (4)

    4. Plant blade-like with round hollow stem. Blade of plant about 1/2 inch to 1 1/2 inches wide. Found growing on rocks or other plants.

    ENTEROMORPHA

    4. Plant blade-like with many holes. Looks like wilted lettuce that has been torn. Stem is flat. SEA LETTUCE (ULVA)

5. Plants olive green, tan or dark brown in color. (6)

5. Plants redish, rose red, purple brown, brownish red or almost black (16).

    6. Plant with no branches. Looks like a green rumpled up sponge.

    LEATHESIA

    6. Plant with branching parts plantlike. (7)

7. Plant found growing on Zostera (eel grass). About the size of a bottle cap.

    PUN CTERIA

7. Plants other. (8)

    8. Plant olive brown. Grows in single stems. Looks like sausage links that taper to a point at the top.

    SCYTOSIPHON

    8. Plant not in single stems. (9)

9. Plant dark brown to black. Round stem that attaches to bottom. A single wide blade, very thin and flat, long pointed ping pong paddle. (10)

9. Plant not flat or blade like. (11)

10. Plant blade has 5 lines from top to bottom. COSTARIA

10. Plant blade usually splits into 3 to 8 long strips. LAMINARIA

11. Plant with great long stem up to 25 yards long. The top is shaped like a light bulb with 6 to 8 flat blades growing from it, without hair. Looks like a bull whip - bullkelp NEREOCYSTIS

11. Plant with a type of branching. (12)

12. Plant with stem, next to the hold fast 10 to 40 leaves grow straight out. The rest of the stem is a wide leaf with ruffled edges. Its length is up to 40 feet. ALARIA

12. Plant with more branches. (13)

13. Flat leaves grow from flat branches. The end of each leaf has two bulbs with bumps on them. FUCUS

13. Leaves grow from flat or round branches. (14)

14. Plants with many small round to oval bulbs on each branch. (15)

14. Plant with round or flat branches with no bulbs. Excretes sulfur and will kill other plants around it as well as itself. Many different forms; one species blade like. DESMARESTIA

15. Plant branches with bulbs that have a leaf growing from the head of each bulb.

MACROCYSTIS

15. Plant branches with bulbs without leaves growing from them. SARGASSUM

16. Plant branches with many hard shell-like segments growing on top of each other. Usually redish pink in color. CORALLINA

16. Plant not hard or shell-like. (17)

Algae Key (cont.)

17. Plant large and flat. (18)

17. Plant not large and flat. (23)

    18. Plant with very little stem or no stem at all. Brownish purple in color. There is no branching. PORPHYRA

    18. Plant with branching. (19)

19. Plant on stem and blade grows on the blades of eel grass. Purplish red to deep purple in color. SMITHORS

19. Plant flat with branching from stem. (20)

    20. Plant with branching from stem. Large forms only (21)

    20. Plant with branching from stem and there are small types to large types. (22)

21. Plant in water or out. Shines a blue or purplish blue color. IRIDEA

21. Plant when put up to light shows many vein like lines throughout the whole plant. POLYNEURA

    22. Plant with very rough surface like very heavy sandpaper or a rough towel. GIGARTINA

    22. Plant large, some small sizes. Blade-like leaves have small holes over the entire surface. RODYMENTIA Small sizes do not have holes.

23. Plant has round stems and round branches. No flat leaves. Up to 18 inches long. AGARDHIELLA

23. Plant has flat stem and branches. (24)

    24. Plant stem is long broad and flat, tapering like a ribbon, with small flat branching leaves sticking out here and there. PRIONITIS

    24. Plant stem and blades flat. Holfast somewhat rounded. Some blades look like flattened hands. End of branches are split. CALLOPHYLLIS

Marine Science 8/74

COLLECTION AND OBSERVATION TECHNIQUES FOR PLANTS AND ANIMALS

PLANTS

Materials:

1. Handout "Key to Common Marine Algaes"
2. Book "Marine Algaes of British Columbia" by Scaegres
3. Plastic Bucket
4. Herbarium press
5. Blotter paper
6. Wax paper
7. Biology paper
8. Razor blade
9. Glass slide and cover slip
10. Monocular microscope
11. Sea water
12. Eye dropper
13. Corrugated cardboard
14. Newspaper
15. Paper towels
16. Meter stick
17. String
18. Wooden stakes
19. Filter paper strips
20. Small test tube
21. Cork for test tube
22. Paper clip
23. Acetone
24. Solvent
25. 50 ml graduated cylinder
26. Mortar
27. Funnel
28. Small beaker

Directions:

Follow all directions carefully. Do exercises #1 and 2 and any one of the two remaining exercises.

EXERCISE I

PART I

Get materials #1, 2 and 3. With your Instructor, go to a rocky intertidal beach at a low tide (preferably a minus tide). Start at the highest tide mark and work you way down to the water line. First, try to be as careful an observer as you can, getting down on your hands and knees if you need to. How many different algae forms can you count?_____

After you have found as many different species as possible, pick one specimen of each species to take back to the lab for plant pressing. Make sure that the plant is still attached, alive and in good shape. Choose your specimens so that they will fit on a standard sheet of paper. Pick the plant at the closest point to the rock that you can so that you get as much of the holdfast as possible.

You should have water in your collection bucket at all times and should change it frequently. (There are many small animals living on the plant that will die if they don't have water and would spoil the plant for pressing.)

If you have to leave the plants overnight before pressing them, be sure that they have air bubbling in the water with them.

COLLECTION AND OBSERVATION TECHNIQUES FOR PLANTS AND ANIMALS

PART II

Get materials #4, 5, 6, 7, 13 and 14. When you get back to the lab, press your specimens as follows:

1. Write your initials on the back side of herbarium sheet, in pencil. Separate the desired specimens for mounting. The specimen may be arranged on the sheet by dextrous use of probes and fingers. If necessary, slide the herbarium sheet under the specimen so that the specimen floats onto the sheet. Blot water from plant with paper towels. Place the herbarium sheet in the press.

2. The press is arranged as follows:

Top: ½" plywood cover and weights
corrugated cardboard
blotter
newspaper
waxed paper (cover specimen only)
herbarium paper
newspaper
blotter
} Make an algae "sandwich"

Bottom: corrugated cardboard, etc. Continue with next herbarium sheet, etc.

3. A period of 2-5 days will be required to press the algae. Blotters and newspaper are to be changed each day. Wet blotters are dried by placing them in a drying rack between corrugated cardboard. As soon as specimens are deemed dry, they are removed from the press. Waxed paper should be peeled off carefully. Previous initialling will identify owner. With the Key, attempt to identify your specimen.

4. A herbarium label may be affixed to each specimen sheet including the following information:

Scientific name of the specimen

Location of collection

Description of habitat from which specimen was collected

Special remarks concerning specimen

Name of collector

Date of collection

Name of the person who determined the species

5. Use your algae key to identify the Genus and Species names of the plants. If you can't find the name in your key, use"Marine Algaes of British Columbia". Hand in your specimens, when you complete them, to your Instructor for grading.

COLLECTION AND OBSERVATION TECHNIQUES FOR PLANTS AND ANIMALS

EXERCISE II

Get materials #8, 9, 10, 15 and a green, red and brown algae specimen of any species. Examine each specimen closely. What advantages does each plant have being shaped the way it is?

Green _____

_____

Brown _____

_____

Red _____

_____

Are there any disadvantages to any of the shapes? _____

_____

Why? _____

_____

Make a cross-section of the holdfast stem and blades of each of the specimens. Prepare a normal slide with each cross-section facing up. Examine each slide on all three objectives. Is there a difference in the cell structure of each plant? _____ Between

plants? _____

Draw the cell structure of the cross-section as you see it under the microscope for each plant.

COLLECTION AND OBSERVATION TECHNIQUES FOR PLANTS AND ANIMALS

EXERCISE II (CONTINUED)

GREEN			
RED			
BROWN			

EXERCISE III

Get materials #1, 2, 3, 16, 17 and 18. Your task is to compare the variety of marine plants at various tide levels and locations on the beach. Your Instructor will take you to a suitable beach, where you are to do the following observations and exercises:

1. Choose four places at different tide height and location on the beach. At each of these "stations" mark out a <u>one meter square</u> area using the stakes and string. (NOTE: If the beach is too rocky, lay the stakes down or use rocks for the corner markers.)

2. Identify how many species are in each station.

COLLECTION AND OBSERVATION TECHNIQUES FOR PLANTS AND ANIMALS

EXERCISE III (cont.)

2. (cont.)

Station #1_____

Station #2 _____

Station #3 _____

Station #4 _____

Does each station have the same number of species? _____

Explain why _____

_____

_____

3. Give at least two reasons why there are more species in the lower tide zone than the higher tide zone. _____

_____

_____

4. If you were a marine plant, what would be the most ideal place on the beach to live? _____

_____

What reasons can you give to show why that place would be the best? _____

_____

_____

EXERCISE IV

Get materials #12, 19 thru 28 and a green algae sample. Your task is to find out how many pigments are in a typical green algae. Your instructor will help you set up and run this experiment.

Procedure

1. Assemble the apparatus as show, but do not add the solvent until you are ready to begin the separation. Bend a paper clip into the shape of a long "J" and force the long end into the bottom of a cork. Cut a strip of filter paper so that its width is slightly less than the inside diameter of the larger test tube and its length is such that it will hang without

COLLECTION AND OBSERVATION TECHNIQUES FOR PLANTS AND ANIMALS

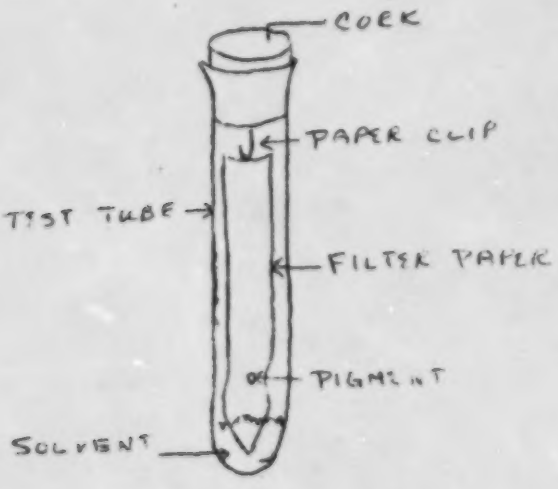
EXERCISE IV

Procedure (cont.)

touching the bottom of the test tube. Cut notches in the strip. Pour solvent into the test tube to a depth of about 1.5 cm. Place the cork with the hook attached (but without the strip of filter paper) in the test tube. Place the tube in an upright position in a holder.

2. Place two or three small algae pieces, a little fine sand, and about 5 ml. of acetone in a mortar, and grind thoroughly. Place a layer of filter paper in a funnel, and add a layer of cleansing tissue. Pour the acetone (which contains the extracted pigment) into the funnel, and collect the filtrate in the smaller test tube. What is the color of the filtrate? Is there any evidence that more than one pigment is dissolved in the acetone?

3. Support the strip of filter paper across two pencils so that the portion between the notches does not touch the table. Using an eye dropper, place a drop of the pigment extract on the paper, between the notches. Allow the drop to dry. Add another drop in the same place, and allow it to dry. Repeat until a total of twenty to thirty drops have been placed on the paper, one on top of the other. When the final drop has dried, remove the cork from the test tube, hang the strip on it, and place it in the test tube. The level of the solvent must be well below the spot (at least 1 cm). Be sure the cork is tight. Watch the solvent rise in the filter paper. When the upper edge of the solvent almost reaches the hook, remove the cork (with the filter paper attached) from the tube and hold it until the solvent is dried.



COLLECTION AND OBSERVATION TECHNIQUES FOR PLANTS AND ANIMALS

EXERCISE IV

Procedure (cont.)

4. Examine the chromatogram. How many bands of color can you see? How many of the bands might be made up of chlorophylls? What other colors can you see in the chromotogram? Why can't you see these pigments in the leaf? Suggest a reason to explain the change of color that often occurs when a leaf dies.

5. Now consider the process by which the pigments were separated. How do you know that all the pigments were dissolved in the solvent you used? From what point did all the pigments start as the solvent began to rise?

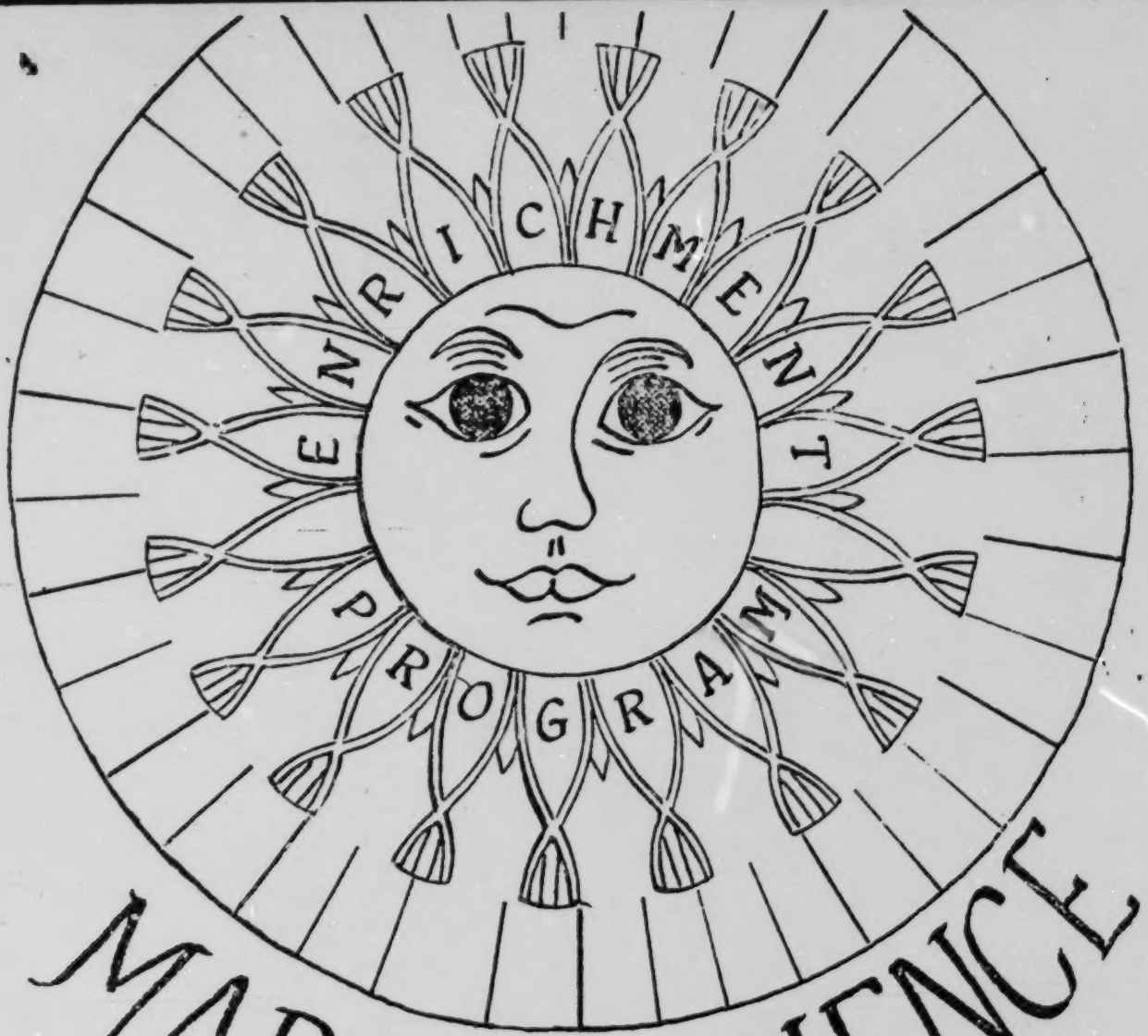
DRAWING ACTIVITY -- No. 3

Materials:

1. Paper (provided)
2. Pencil
3. Plant (provided)
4. Tray

Directions:

1. Draw in complete detail two (2) angles of your plant.
2. Label parts in horizontal fashion.
3. Supply five (5) interesting facts. (How could this animal be used commercially? Why is this plant found where it is? Etc.)



MARINE SCIENCE

OCEANOGRAPHIC INSTRUMENTS

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OCEANOGRAPHIC INSTRUMENT USAGE

Title III
Marine Science

5/74

OCEANOGRAPHIC INSTRUMENT PACKET

Water Quality Sampling

Materials:

1. Van Doren bottle
2. Hydrowire
3. Messenger
4. Five sample jars with lids
5. Bucket thermometer
6. Secchi-disc
7. Ule scale
8. Meter stick
9. Potassium chloride solution ($KcrO_4$)
10. Silver nitrate solution ($AgNO_4$)
11. 10 ml pipette
12. 50 ml graduated cylinder
13. Clorinity to salinity conversion tables
14. 250 ml beaker
15. Automatic burette
16. Magnetic stirring table
17. Waste materials bottle

Directions:

Do part 'A' at some suitable location for sample taring (salt water over ten feet deep). Do part 'B' back at the lab. Be very precise and accurate in all measurements.

Part A:

Get materials numbers 1-8. Pick five separate locations to take samples from. Using the Van Doren bottle, obtain the samples from a depth of 1 meter. (Have your instructor show you how to use the Van Doren bottle.) Record the temperature of the water and fill one sample bottle with the sample water taken, at each station. Take a secchi disc reading at each station by lowering the disc into the water until it is barely visible. Record this depth by measuring the length of the line from the disc to the surface. Also take a ule scale reading by lowering the secchi disc into the water 1 meter and comparing the color of the disc with the tube on the scale of the same color. Record that number. Return all equipment to the lab for analysis of your sample water.

Station 1

Water temperature _____
Secchi disc depth _____
Ule scale reading_____

Comments _____

_____

Station 2

Water temperature _____
Secchi disc depth _____
Ule sclae reading _____

Comments _____

_____

Station 3

Water temperature _____
Secchi disc depth _____
Ule sclae reading _____

Comments _____

_____

Station 4

Water temperature _____
Secchi disc depth _____
Ule Scale reading _____

Comments _____

_____

Station 5

Water temperature _____
Secchi disc depth _____
Ule scale reading _____

Comments _____

_____

Part B

Get materials numbers 9-17 to determine the salinity of your samples.

1. Make sure your glassware is clean.
2. Using the 10 ml pipette, place 10 ml of your sample water in a beaker.
3. Measure out 15 ml of $KCrO_4$ (potassium chromate) using the graduated cylinder and add that to your beaker of sample.
4. Place the beaker on the magnetic stirring table and put the stirring rod in the beaker. Turn the table on to medium stirring speed.

Part B (cont.)

5. Fill the burette up to the automatic zero mark by putting your finger over the vent tube and squeezing the bulb. (Make sure the stopcock is closed)
6. Begin the titration by carefully opening the stopcock so that you are adding one drop of solution at a time. As the concentration of silver nitrate approaches the end point (the amount added that is exactly enough to turn the solution from yellow to red), be very careful that you do not add any extra after the solution turns red.
7. After the end point is reached, read the scale on the burette as accurately as you can to determine how much silver nitrate you added. Record this number for each sample.
8. To find the salinity of the water, use the clorinity-salinity conversion chart. The numbers under the Cl column are the burette readings. The numbers in the column marked S o/oo are the salinity readings in parts per thousand (o/oo). Record the salinity for all samples.

Station 1- _____ Station 4- _____

Station 2- _____ Station 5- _____

Station 3- _____

Were all the answers the same? _____

Why or why not? _____

_____

Were the Secchi Disc and Ule scale readings the same? _____

Explain _____

_____

_____

Explain why you think the water has different chemical properies at different places. _____

_____

_____

OCEANOGRAPHIC INSTRUMENTS PACKET

PRIMARY PRODUCTIVITY COUNTS

Materials:

1. Plankton net (fine mesh)
2. Sample jars
3. Secchi disc and ule scale
4. Weather station data
5. Meter stick
6. Putty knife or scraper
7. Plastic bucket
8. Triple beam balance
9. Paper towels
10. Stereoscope
11. Counting grid
12. Petrie dish
13. 10 ml. pipette
14. Book - "Coastal Marine Plankton"

Directions:

Do exercise #1 and then choose between #2 and #3 to find out the primary productivity of the Bay.

It is extremely important for Scientists to study the productivity of the Sea so that we know it's potential food value. The Farmer can determine the productivity of his acreage in terms of so many bushels of wheat, corn, potatoes, etc. For Marine Studies, a different method must be used. Plankton tows or algea transect studies are the Oceanographers method of determining how much food energy is being produced by the marine plants (primary producers) during a given period of time.

PART I

Get materials #3, 4, and 5. Your task is to qualify your primary productivity count by measuring the turbidity of the water and the prevailing weather conditions. This is necessary because water turbidity and cloudy weather both cut down on food production by plants (decreased amount of sunlight energy available to the plants).

Take a secchi disc reading by lowering the disc into the water until you can barely see it. Mark the line where it hits the water at that time. Pull the disc up and measure the distance between the mark and the disc. Record this on your data table.

Next, lower the disc into the water exactly one meter for the ule scale measurement. Unfold the ule scale and look through the different colored viles at the disc. Record the number of the vile that matches the color of the disc.

After these measurements, record all the weather data called for on the data sheet, from the weather station. These three measurements are to be taken before each plankton tow or transect sampling.

PRIMARY PRODUCTIVITY COUNTS

DATA SHEET

Date _____

Time _____

Location _____

Secchi Disc
Depth _____ .meters

Ule scale reading _____ _____

Weather Data

Wind speed _____ knots

Wind direction _____

Cloud cover _____ %

Water condition (circle) - flat, slight ripple, small chop, large chop, some whitecaps, total whitecaps.

Precipitation _____

PRIMARY PRODUCTIVITY COUNTS

PART II

Get materials #1, 2, 10, 11, 12, 13 and 14. Your task is to measure the amount of plant plankton present in a cubic meter of sea water at one week intervals. To determine this see pink hand-out.

Can you see any relationship between the data from exercise #1 and the amount of plankton present in your tows for each sampling?

_____

_____

Give some reasons why you think this is true._____

_____

_____

From your observations, when do you think the most primary productivity takes place during the year? When does the least productivity take place? _____

_____

_____

PART III

Get materials #5, 6, 7, 8, 9 and a drying oven. Your task is to measure the primary productivity of a typical algae with a fast growth rate. Ulva or enteromorpha, both rapidly growing green algae, are well suited for measuring this.

1. Pick a surface such as a floating raft or log or submerged hard surface at medium tide height. Mark off 5, 10cm square areas of equal environmental conditions (same sunlight exposure, water circulation, etc.).

2. Scrape off and save all traces of algae from one section each time you come to the lab. Make sure to get as much of the algae as you can without getting pieces of wood, barnacles, etc. in your sample.

3. Take your sample and carefully blot off all excess water with toweling or tissue without losing any sample. Leave your sample on toweling and place it in the drying oven until all the water is out of the algae. (Important note: Be <u>sure</u> to weigh the paper toweling that you dry your samples on.

PRIMARY PRODUCTIVITY COUNTS

PART III (cont.)

4. After all your samples are dry, weigh each sample on the paper toweling, using the triple beam balance. Accuracy is very important so be sure and check all of your measurements. Subtract the weight of the toweling from the total weight to get the true weight of the algae sample. Record your answers below

Sample #1 _____ gm. _____ date collected

#2 _____ gm. _____ date collected

#3 _____ gm. _____ date collected

#4 _____ gm. _____ date collected

#5 _____ gm. _____ date collected

5. Was there a difference between the samples? _____

Explain why you think there was or could be a difference.

_____

_____

_____

From your measurements, could the difference have been from environmental conditions? _____ In what way?

_____

_____

_____

What are the main factors controlling growth in algae?

_____

_____

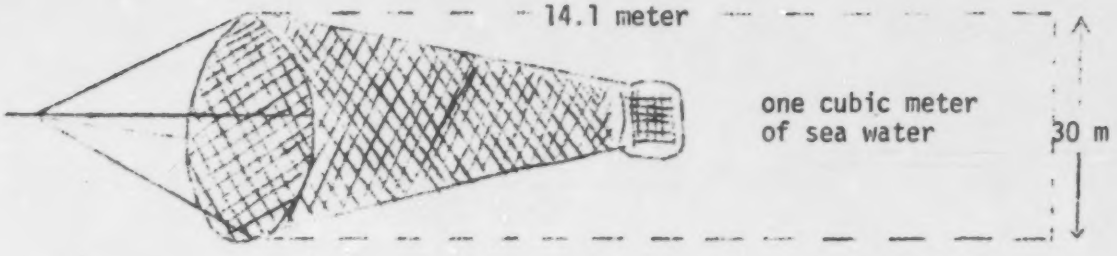
_____

Marine Science

PRIMARY PRODUCTIVITY COUNTS

To determine the number of plankton in one cubic meter of sea water:

Tow a standard size plankton net a total distance of 14.1 meters in order to obtain the plankton from one cubic meter of sea water.



The volume of the tow is one cubic meter of sea water which has to go through the plankton net.

Pipette 10 ml of water from the 400 ml jar that is used with the plankton net. You now have 1/40 of the sample to put in your petri dish.

Place a 250-square counting grid under your petri dish. If you count the number of plankton in 10 squares you are counting 1/25 of the total plankton in the tow.

Once you have a total number of plankton in your ten squares, you multiply that number by 25 (because you only counted 1/25 of the squares in the dish); and then by 40 (because your dish contains 1/40 of the total plankton in the tow).

HINT: 25 x 40 = 1000, so you only have to multiply your total by 1000.

Record all data on the attached worksheet.

Count only the phytoplankton in your sample. (See "Coastal Marine Plankton" for pictures of phytoplankton)

Marine Science

PRIMARY PRODUCTIVITY COUNTS

WORKSHEET

Name _____ Date of tow _____

Location of tow _____ Time of day _____

Square No.	Number of plankton
3	_____
7	_____
24	_____
30	_____
70	_____
95	_____
120	_____
180	_____
200	_____
240	_____

TOTAL: _____ x 1000 = _____ (number of plankton in tow)

OCEANOGRAPHIC INSTRUMENT PACKET

HYDROGRAPHIC STUDIES

Materials:

1. Fathometer or Lead Line
2. Hydrographic Boat
3. Core sampler
4. Bottom Grab
5. Sample Bottles (5)
6. Cardboard Boxes
7. Tracing paper
8. Plastic pan
9. Sharp pair of scissors
10. Elmers glue
11. Watercolor Pens
12. Chart of Liberty Bay (Boat Sheet)
13. Compass
14. Fathometer chart paper
15. Matboard

Directions:

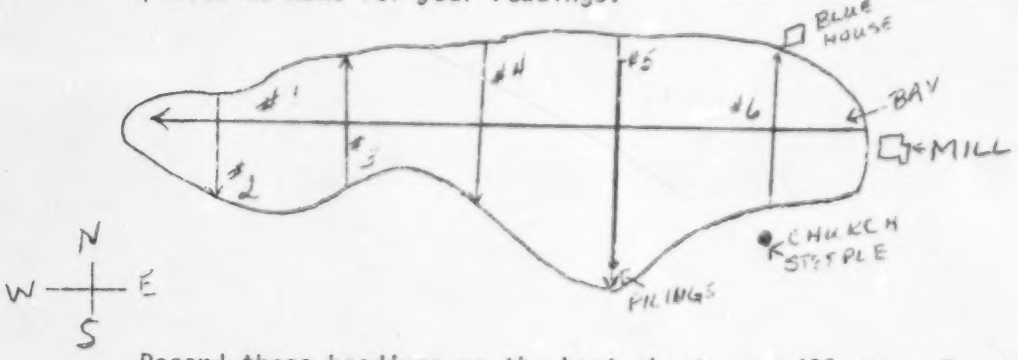
With a partner, complete part I and then choose between doing part II or part III. Your final product should be turned in to your Instructor.

PART I

Get materials #1, 2, 3, 4, 5, 8, 12, 13 and 14. Your job is to chart the bottom contours of Liberty Bay and use this data to complete part II and part III.

In doing hydrographic surveys like this, accuracy is very important in al measurements, especially your position in relation to land.

1. With your Instructors help, decide which directions and how many passes to make for your readings.



Record these headings on the boat sheet you will use. Try to pick headings that are easy to follow and that have landmarks on each end so that you can find them exactly when you are on the water (see example).

HYDROGRAPHIC STUDIES (cont.)

PART I

2. Using the Hydrographic boat, make at least two passes on each heading. During the passes, one person should be recording the depths, on the Fathometer chart paper at 15 second intervals, while the other partner is making sure the boat is always on the proper course. It is the second partner's job to tell the skipper if a direction change is needed (and in what direction) to stay on course.

   After you have completed all of your depth runs, go back and make bottom samples using the bottom grab and core sampler. Take samples at intervals determined by your Instructor. Carefully observe your samples for:

   1. Type of soil (rock, clay, mud, sand, etc.)
   2. Animals found (clams, worms, etc.)
   3. Change in sub-bottom soil (is the core sample different than the bottom grab and why).

   Record your notes on each data sheet then number the location of each sample number taken on your boat sheet.

HYDROGRAPHIC DATA SHEET

A. Sample # _____ Course # _____

Location _____ Type of bottom _____

_____

Animals present _____

Sub-bottom type _____

Comments: _____

_____

B. Sample # _____ Course # _____

Location _____ Type of bottom _____

_____

Animals present _____

Sub-bottom type _____

Comments _____

_____

C. Sample # _____ Course # _____

Location _____ Type of bottom _____

_____

Animals present _____

Sub-bottom type _____

Comments _____

_____

D. Sample # _____ Course # _____

Location _____ Type of bottom _____

_____

Animals present _____

Sub-bottom type _____

Comments: _____

HYDROGRAPHIC STUDIES

PART II

Get materials #7, 11, 15 and your completed boat sheet, data sheets and Fathometer chart paper.

Your task is to make a Hydrographic chart of the Bay using your Hydrographic data. Give all depth soundings and use different colored areas to represent different bottom types.

Trace an outline of the Bay from the boat sheet to the tracing paper and then transfer that to the matboard using a real chart as an example. Put the depths on your matboard for the courses you ran. How would you fill in the depth readings between those courses? _____

_____

Fill in those unknown depths and explain how you did it._____

_____

_____

Using your data sheet, pick different colors to represent bottom types, then fill those in on your matboard chart. How could you tell what kind of bottom is there on an untested section? _____

_____

_____

Next, label all reference points on the matboard that you used for your courses. Other labels should include compass rose, landmarks, towns, legend, etc.

Turn in your completed matboard chart to your Instructor.

PART III

Get materials #6, 7, 9, 10 and your completed boat sheet, data sheet and Fathometer chart paper. Your task is to make a three dimensional chart of the Bay (similar to a relief map) using the cardboard to represent the levels of the same depth. See your Instructor for an example.

Start by drawing contour lines on your boat sheet by connecting all the points of equal depth in a continuous line (Your Instructor will show you how).

HYDROGRAPHIC STUDIES

PART III (CONT.)

When all you contour lines are completed, transfer them and the outline of the Bay onto tracing paper. The tracing paper can then be used as a guide to give the correct shape and relationship to the cardboard layers. The individual layers should then be cut and glued together and pressed until the glue is dry. The chart should then be painted or colored so that the land is green and the different bottom types are represented by different colors.

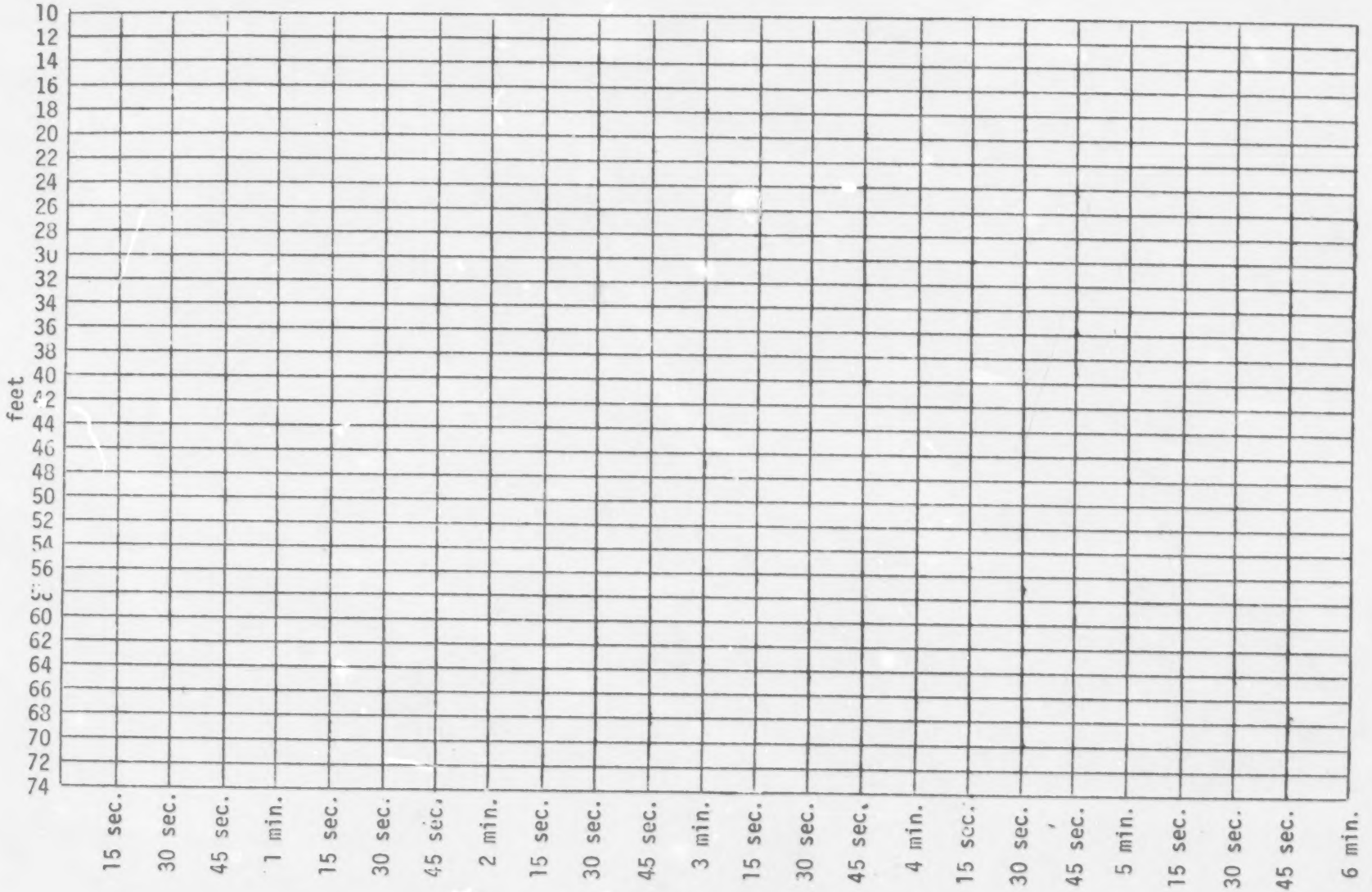
After the chart has been colored, add on all additional details that you feel are important to your chart to make it usable. Things like landmarks, towns, large buildings and a compass rose should be included.

Turn the final product into your Instructor for grading

Marine Science
Hyrographic Studies

COURSE #_____ PASS #_____ COMPASS READING_____

DEPTH RECORDED IN FEET



A Glossary of Some Common Oceanographic Terms

Aquaculture -- Fish, shellfish, and algae farming

Bathythermograph -- (BT) A device for obtaining a record of temperature plotted against pressure or depth

Bay -- A recess in the shore or an inlet of a sea

Beach -- The zone of unconsolidated material extending inland from the low water line to where a marked change in material or permanent vegetation occurs

Benthic -- That portion of the marine environment inhabited by marine organisms which live in or on the bottom

Benthos -- Bottom dwelling forms

Bioluminescence -- Light produced by animals

Bucket thermometer -- A thermometer used to measure the temperature of a bucket of water drawn from the surface of the sea

Chart -- A special purpose map generally designed for navigation

Core -- A vertical, cylindrical sample of the bottom sediments from which the nature and stratification of the bottom may be determined

Detritus -- Any loose material produced directly from rock disintegration

Diatoms -- Single celled microscopic plants forming a major component of plankton

Ebb current -- The tidal current associated with the decrease in the height of a tide. Ebb currents generally set seaward, or in an opposite direction to the tide progression. Erroneously called ebb tide.

Echo sounding -- Determination of the depth of water between emission of a sonic or ultrasonic signal and the return of its echo from the bottom. The instrument used for this purpose is called an echo sounder.

Estuary -- A tidal bay formed by submergence or drowning of the lower portion of a nonglaciated river valley and containing a measurable quantity of sea salt

Fathom -- The common unit of depth in the ocean for countries using the English system of units, equal to 1.83 meters.

Flood current -- The tidal current associated with the increase in the height of a tide. Flood currents generally set toward the shore, or in the direction of the tide progression. Erroneously called flood tide.

Littoral zone -- An area extending from shoreline to the edge of the continental shelf or to the 200 meter depth line

Nautical mile -- In general a unit used in marine navigation equal to a minute of arc of a great circle on a sphere. Depending upon the radius of the sphere, various lengths of nautical miles have been defined. The adopted value in the United States since July 1, 1959 is one international nautical mile equals 6,076.11549 U.S. feet (approximately)

Nekton -- Those animals of the pelagic division that are active swimmers, such as most of adult squids, fishes, and marine mammals

Ocean -- 1. The intercommunicating body of salt water occupying the depression of the earth's surface.
2. One of the major primary subdivisions of the above, bounded by continents, the Equator, and other imaginary lines.

Oceanography -- 1. The study of the sea, embracing and integrating all knowledge pertaining to the sea's physical boundaries, the chemistry and physics of sea water, and marine biology.
2. In strict usage oceanography is the description of the marine environment, whereas oceanology is the study of the oceans and related sciences.

Offshore wind -- A wind blowing landward from the sea in a coastal area; a sea breeze

Phytoplankton -- The plant forms of plankton. They are the basic synthesizers of organic matter (by photosynthesis) in the pelagic division. The most abundant of the phytoplankton are the diatoms.

Plankton -- The passively drifting or weakly swimming organisms in marine and fresh waters. Members of this group range in size from microscopic plants to jellyfishes measuring up to six feet across the bell, and include the eggs and larval stages of the nekton and bethos. See phytoplankton and zooplankton.

Plankton bloom -- An enormous concentration of plankton (usually phytoplankton) in an area, caused either by an explosive or a gradual multiplication of organisms (sometimes of a single species) and usually producing an obvious change in the physical appearance of the sea surface, such as discoloration. Blooms consisting of million of cells per liter often have been reported. See red tide.

Rising tide -- The portion of the tide cycle between low water and the following high water

Salinity -- A measure of the quantity of dissolved salts in sea water. It is formally defined as the total amount of dissolved solids in sea water in parts per thousand (0/00) by weight when all the carbonate has been converted to oxide, the bromide and iodide to chloride, and all organic matter completely oxidized.

Sediment -- Particulate organic and inorganic matter which accumulates in a loose unconsolidated form. It may be chemically precipitated from solution, secreted by organisms, or transported by air, ice, wind, or water and deposited.

Tide -- The periodic rising and falling of the earth's oceans and atmosphere. It results from the tide-producing forces of the moon and sun acting upon the rotating earth. This disturbance actually propagates as a wave through the atmosphere and through the surface layer of the oceans.

Turbidity -- Reduced water clarity resulting from the presence of suspended matter. Water is considered turbid when its load of suspended matter is visibly conspicuous, but all waters contain some suspended matter and therefore are turbid.

Wave -- A disturbance which moves through or over the surface of the medium (here, the ocean), with speed dependent upon the properties of the medium.

Wave crest -- The highest part of a wave. Also the part of the wave above still water level.

Wavelength -- The distance between corresponding points of two successive periodic waves in the direction of propagation, for which the oscillation has the same phase. Unit of measurement is meters.

Wave period -- The time, in seconds, required for a wave crest to traverse a distance equal to one wavelength.

Wave trough -- The lowest part of a wave form between successive wave crests. Also that part of a wave below still water level.

Zooplankton -- The animal forms of plankton. They include various crustaceans, such as copepods and euphausiides, jellyfishes, certain protozoans, worms, mollusks, and the eggs and larvae of benthic and nektonic animals. They are the principal consumers of the phytoplankton, and in turn, are the principal food for a large number of squids, fishes, and baleen whales.

SCIENCE PROBLEM SITUATIONS

TO BE USED AS CULMINATION PROJECTS OR AS

EVALUATION ACTIVITIES TO GO WITH PACKETS IN:

--Labware

--Metric

--Microscope

--Animal

--Plant

--Glassware

--Oceanographic

SCIENCE PROBLEM SITUATIONS

Type I--Very directed marine science problem situations where the student is asked to apply his critical and analytical thinking skills, along with his acquired marine science knowledge, to a fairly structured framework prepared by the instructor.

Type II--Open-ended marine science problem situations where the student is asked to come up with one or more possible ways to attack a problem to obtain the answers. Here, the student is asked to synthesize his own framework, variables, constants, methods analysis, etc.

In both Type I and II situations the student is asked not only to come up with a theoretical way of resolving the situation, but also carry out that method in the form of an experiment. The student must complete at least one Type I problem to the satisfaction of the instructor before he can begin any Type II problems.

In order to meet the proficiency level for each packet the student must complete at least two Type I problems and at least one Type II problem to the satisfaction of the instructor.

LABWARE PACKET
Evaluation Experiments

TYPE I No. 1

Directions: You are to measure the internal volume of 3 sea squirts (one at a time). Choose the correct measuring tools to do the job (graduated cylinder, pipette, or beaker).

Procedures: Select three glassy sea squirts from the sea water trough (have your instructor help you). Place them in a finger bowl of sea water and gently squeeze out as much water as possible without injuring the animal. Immediately transfer your animal to another measuring container (a graduated cylinder with 15 ml of sea water in it). Take a measurement of what the new water level is and remove the animal. Put the animal in again and let it start filling with water again. After it is full, remove it and again measure, as accurately as possible, the water level. To get the final answer, subtract the second measurement from the first (this gives the volume of the sea squirt's body). Then subtract the first measurement from the last to get the total volume of the animal's body and the water within him. Tell your instructor how you would find the final volume (the water inside the sea squirt). Record all these readings under Data. Repeat the experiment for the other two sea squirts. Tell if they are the same or different and why. Also, put any errors you had down under Data.

Data

Conclusions: Was your experiment a success? _____ Why?

_____

_____

_____

How could you have done it better? _____

_____

_____

METRIC PACKET
Evaluation Experiments

TYPE I No. 1

Directions: Give an example of a metric unit of length, volume, and mass. Which unit would you use to express the displacement of a boat? size of a sea urchin? amount of shell present on an oyster?

Procedures:

Metric Length _____

_____

Volume _____

_____

Mass _____

_____

Displacement of boat:

_____

Size of sea urchin:

_____

Amount of shell present on an oyster:

_____

METRIC PACKET
Evaluation Experiments

TYPE I No. 2

Directions: Read the following problem carefully and put your answer below the question. Explain to your instructor how you solved the problem.

Question: If the average length of a sea urchin spine is 2 centimeters long, how many spines would it take to measure one kilometer if you lined them up end to end?

Procedure:

1. Explain your method to your instructor.
2. Find an urchin in the tanks and measure 10 spines with a centimeter rule. What is the average length of these spines?

   What does the urchin use the spines for?

METRIC PACKET
Evaluation Experiments

TYPE I No. 3

Directions: Answer the questions the best that you can, either on this paper or to your instructor.

Questions: How is the metric system easier to use than the English system? List any common examples of a base 10 system (like the metric system) that we have in this country.

Procedures:

1. _____

2. List:

MICROSCOPE PACKET
Evaluation Experiments

TYPE I No. 1

Directions: Find the following parts of the dissecting microscope. Identify them to your instructor and make a drawing (with labels) of it.

1. Ocular
2. Top stage light
3. Bottom stage light
4. Focus knob
5. Adjustable eyepieces
6. Light knobs
7. Magnification adjustment

Procedures: Put your drawing at the left and all of your labels on the right. Use arrows to connect the part with the name.

DRAWING	LABELS

MICROSCOPE PACKET
Evaluation Experiments

TYPE I No. 2

Directions: Find the following parts of the compound microscope. Identify them to your instructor and make a drawing (with labels) of it.

1. Eyepiece
2. Oculars
3. Iris
4. Diaphram
5. Fine focus knob
6. Course focus knob
7. Slide holder clips
8. Light switch
9. Bulb replacement

Procedures: Put your drawing at the left and all of your labels on the right. Use arrows to connect the part with the name.

DRAWING	LABELS

MICROSCOPE PACKET
Evaluation Experiments

TYPE I No. 3

Directions: Using the dissecting microscope, examine the top (aboral) surface and the bottom (oral) surface of a green sea urchin. Put the urchin in a finger bowl of sea water for examination. Watch the movement that you see on both sides. Stimulate the urchin by tapping on the shell lightly with a pencil point. Describe the movement you see under Data. Draw what you see happening under Diagram.

Procedures:

Data - (Describe what you see on both sides.)

Diagram - Put your drawing on the left and all of your labels on the right. Use arrows to connect the part with the name. Draw only what you see moving and label those parts.

DRAWING	LABELS

ANIMAL PACKET
Evaluation Experiments

TYPE I No. 1

Directions: Classify (identify) two animals that your instructor gives you. Use only the key provided. If you do not understand a term or word, look in the index or ask your instructor. Draw the most detailed diagram of the animals that you can, and label all the parts. Answer the questions below the space for your diagrams.

Procedures: Common name: _____

Scientific name: _____

Diagram: Put your drawing on the left and all of your labels on the right. Use arrows to connect the body part with the name.

DRAWING	LABELS
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	_____

Questions:

1. What does this animal eat? What parts of its body does it do this with?

_____

_____

2. How does this animal defend itself against predators?

_____

_____

3. Name the parts of the body that the animal moves with.

_____

_____

DRAWING LABELS

Questions:

1. What does this animal eat? What parts of its body does it do this with?

2. How does this animal defend itself against predators?

3. Name the parts of the body that the animal moves with.

ANIMAL PACKET
Evaluation Experiments

TYPE I No. 2

Directions: Using an oyster that your instructor has prepared for you, carefully examine and carry out the steps under procedures.

Procedures:

A. Examine the internal organs and muscle very carefully, using your fingers as a probe. Make sure you can identify all the parts of the oyster. Point out and name them to your instructor.

B. Draw and label all the internal organs and muscles in the space provided. How do each of these parts differ from the clam that you studied? (Write your answers next to your diagram labels of each part.)

DRAWING	LABEL
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	_____

C. Examine the growth pattern of the oyster shell. Explain to your instructor how the shell grows, where it comes from and why it has all those ridges, bumps, and edges. Explain how it is different from the growth pattern of a cockle clam. Are there any things similar about the growth pattern of the oysters and of the clam? What are they?

_____

_____

_____

ANIMAL PACKET
Evaluation Experiments

TYPE I No. 3

Directions: Given the following environmental conditions, design and "conscruct" an animal that would survive the most successfully. Be sure to include some form of each of the body parts below.

1. Food gathering part (something like a mouth)
2. Defense structures
3. Movement structures (like fins or a foot)
4. Digestive part
5. Escape mechanism

Environmental conditions

1. Deep water
2. Lots of plankton
3. Very few fish
4. Not very much oxygen in the water
5. Rocky bottom (lots of hiding places
6. No seaweed
7. Very swift current
8. Cold water
9. Lots of crabs, urchins and starfish around
10. Detritus gets washed away by the current

Procedures: Describe in the space below what each part of your animal is like, then draw a diagram of your animal and label all of the important parts in the spaces provided.

Description

DRAWING	LABEL
	_____
	_____
	_____
	_____
	_____
	_____
	_____

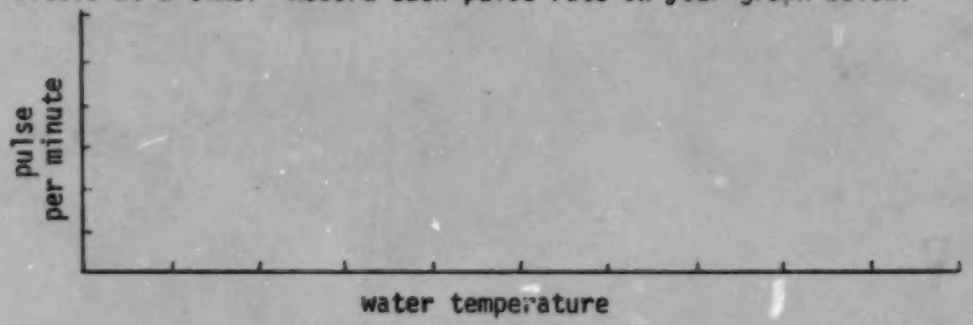
Question: If you were that animal, briefly describe how you would survive during a one week period (eating, staying away from predators, etc.)

ANIMAL PACKET
Evaluation Experiments

TYPE I No. 4

Directions: You are to find out if the temperature of the water affects the respiration rate (breathing) of marine animals. Select a healthy looking sea cucumber from the trays and place him in a plastic tub full of sea water. Record the temperature of the water when you put him in. Keep the thermometer in the water and record it every ten minutes on the graph.

Procedure: Have a partner keep track of the time. To measure the respiration rate of a sea cucumber, place a drop of food coloring or dye near the cloaca. Watch for water pulses from the cloaca (shown by the dye) and time how often these happen. Gradually warm up the water by adding heated salt water to the tub a little at a time. Record each pulse rate on your graph below.



Questions:

1. What happens as you increase the water temperature?_____

_____

_____

_____

2. Why do you think the sea cucumber does this?_____

_____

_____

_____

3. Is there more or less oxygen dissolved in sea water as the temperature goes up?_____

_____

_____

4. What do you think the sea cucumber would do if you lowered the temperature of the water he was in?_____

_____

_____

ANIMAL PACKET
Evaluation Experiments

TYPE II No. 1

Directions: Study the following problem, very carefully. Write your answer under the question and add any diagrams you need to, in the diagram section.

Procedures: There has been a natural ecological disaster in Puget Sound in which almost all of the snail population has been wiped out. How would you go about finding the reasons that may have caused this? List the probable causes for this disaster and other effects they might have on other animals. How would you go about increasing the snail population back to its normal size again? Tell how you would measure the population and what tools you would use.

Diagram:

Tools you would use:

ANIMAL PACKET
Evaluation Experiments

TYPE II No. 2

Directions: Given the following animals and conditions in an aquarium, tell what changes you would find in the ecological balance after about two months.

_____

_____

_____

Procedure:

A. Conditions

1. Low water temperature
2. High salt content
3. Lots of plankton present always

B. Animals

1. Clam
2. Oyster
3. Moon snail
4. Perch
5. Tube worm
6. Urchin
7. Blood star
8. Rock scallop
9. Sea cucumber
10. Snail
11. Mottled star
12. Nudibranch

Questions:

1. How would you correct the imbalance permanently if you found one?

_____

_____

_____

2. What changes would occur if you raised the water temperature 10 degrees?

_____

_____

_____

PLANT PACKET
Evaluation Experiments

TYPE I No. 1

Directions: Using a plant that you didn't find (your instructor will give you one), do the following, under procedures.

Procedures:

1. Tell what kind of beach type you would probably find this plant on.

_____

_____

2. What depth in the water would this plant be at during high tide?

_____

3. Does this plant need any special water conditions to survive? _____

What are they? _____

_____

4. What is the name of this plant (use a key on your own)? _____

_____

5. Draw a picture of your plant.

PLANTS PACKET
Evaluation Experiments

TYPE I No. 2

Directions: Pick out five plant samples and make a microscope slide cross section of each. Make sure the samples are very thin so you can see through them, under the scope. Examine each sample under all the powers (if possible).

Procedures: Draw and label each sample. Give as much detail as you can. Tell how each sample is different from the others.

	DRAWINGS	LABELS
①		_____ _____ _____ _____ _____ _____
②		_____ _____ _____ _____ _____ _____

DRAWINGS	LABELS
③	
④	
⑤	

PLANT PACKET
Evaluation Experiments

TYPE II No. 1

Directions: Design and carry out an experiment that will tell you what times during the year a marine plant is producing the most energy. Predict what the water temperature, salinity and amount of sunlight would be.

Procedures:

1. Time of year _____
2. Water temperature _____
3. Salinity _____
4. Sunlight _____ (month of the year)

Diagram: Draw a diagram of each piece of your equipment and explain how it is used.

DRAWINGS	EXPLANATION

PLANT PACKET
Evaluation Experiments

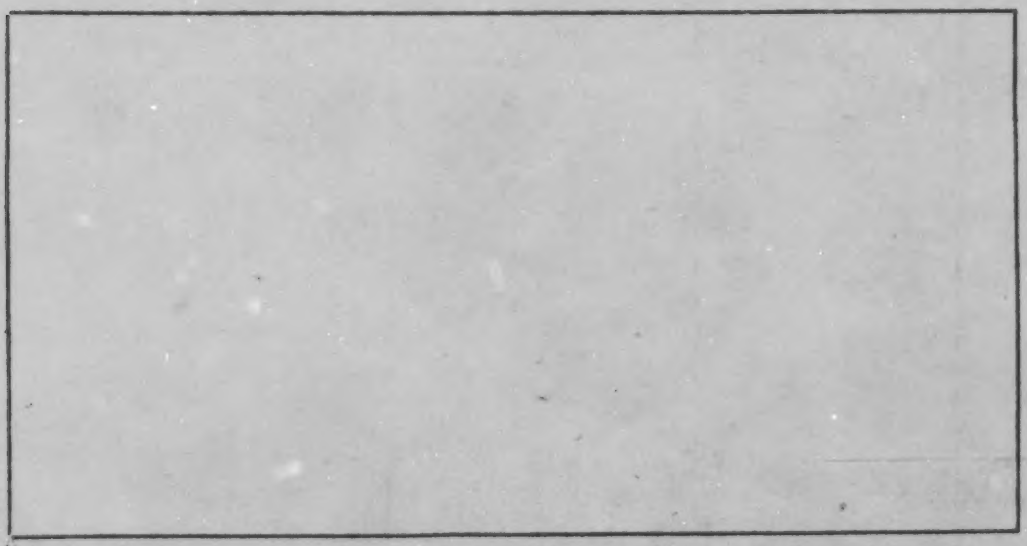
TYPE II No. 2

Directions: Pick a plant of your choice, place it in a tub of water and complete the questions under procedures.

Procedures:

1. Does this plant provide good hiding places for small animals: _____

   Draw what they would look like?



2. What animals might eat this plant? _____

3. Explain how larger animals might use this as a feeding ground?

4. How does this plant help to keep a chemical balance in the water around it?

GLASSWARE PACKET
Evaluation Experiments

TYPE I No. 3

Directions: Find the temperature of the water in the bay, boiling fresh water, boiling salt water and ice water. Add salt to the ice water and record the temperature. When you are done, answer the questions below:

Procedures:

Temperatures

Bay water _____

Boiling fresh water _____

Boiling salt water _____

Ice water _____

Ice water with salt _____

Questions:

1. Is the bay water colder or warmer than the water in the trays? _____

   Why? _____

   _____

2. Are the boiling waters the same temperature? _____ Why?

   _____

   _____

3. Why does the ice water get colder when you add salt? _____

   _____

   _____

4. Explain the difference between a Fahrenheit and centigrade thermometer scale.

   _____

   _____

   _____

   _____

GLASSWARE PACKET
Evaluation Experiments

TYPE II No. 1

Directions: Choose one of the following experiments to do, with equipment that you could make from materials you have around home.

1. Salinity of two samples of salt water
2. The temperature at the bottom of the bay
3. Measure the cloudiness of the water.
4. Trapping a plankton sample to examine
5. Trapping a bottom water sample

Procedure: Make your equipment at home, or bring it to the lab to assemble it. Explain to your instructor how it works, then try it out to see if it works. Answer the right question for your experiment, below.

Questions:

1. Do the two samples have the same salt content? _____ If not, how much are they different? (If you can tell from your instrument)

_____

_____

2. How did you keep the bottom water in and the top water out?

_____

_____

_____

_____

3. Explain how your instrument works. _____

_____

_____

_____

4. Where would be the best place to find a plankton sample in the water?

_____

_____

5. Can you find a difference in the salinity between the top and bottom water? (Use the hydrometer) _____

_____

_____

GLASSWARE PACKET
Evaluation Experiments

TYPE II No. 2

Directions: Design and try to make (if possible) the equipment that could tell you what the water temperature changes were over a one-month period in the bay.

Procedures: Make sure you include in your answer, how you would make it, on what it will record, where you would put it, and why you think this information could be important.

Diagram: Draw and label your equipment as best you can.

DRAWING	LABELS

OCEANOGRAPHIC PACKET
Evaluation Experiments

TYPE I No. 2

Directions: Get the titration and hydrometer equipment from your instructor. Obtain two different samples of sea water from different places for salinity counts. Determine the salinity of each sample using both methods, and record your results under procedures. Answer all questions.

Procedures:

Sample 1 titration _____%

hydrometer _____%

Sample 2 titration _____%

hydrometer _____%

Water temperature _____

Questions:

1. Are the samples the same salinity? _____ Give as many reasons as you can why they are the same or different.

_____

_____

_____

2. If the hydrometer and titration methods gave you different answers, give your reasons why you think this happened.

_____

_____

_____

3. Does salinity change with a change of temperature? _____
Does density change with a change in temperature? _____
Why _____

_____

4. Explain how the sea gets salty and stays about the same salt concentration.

_____

_____

_____

OCEANOGRAPHIC PACKET
Evaluation Experiments

TYPE I No. 3

Directions: You are to find out how many phytoplankton (plant plankton) are in the bay at any one time. Take a normal horizontal plankton tow for 14.1 meters. You now have 450 ml of sample from one cubic meter of sea water. Take 10 ml from that sample, place it in a petrie dish on a grid and count only the plant plankton you find. Your answer should now be multiplied by 1000 to get the correct number of phytoplankton in a cubic meter of sea water.

Procedures:

Number of phytoplankton _____

x 1000 _____

_____ Cubic meter

Liberty Bay has the approximate dimensions of 1000 x 3000 x 30 meters. How may phytoplankton are in the bay (approximately)?

_____

_____

_____

OCEANOGRAPHIC PACKET
Evaluation Experiments

TYPE II No. 1

Directions: Using a photo cell or other device, invent a tool that will tell you how much sunlight has fallen on the bay during a one-week period.

Procedures: Make a series of diagrams and drawings to explain how your tool works. Label all the parts and explain to your instructor how it works.

DIAGRAM	LABELS

Questions:

1. Why is sunlight important to plants?

2. Why is it important to the water itself?

3. Why would a scientist want to use your tool or your experimental results?

OCEANOGRAPHIC PACKET
Evaluation Experiments

TYPE II No. 2

Directions: Construct a tide gauge using a marked pole, float and a recording device that you can invent to measure the tide action for a two-day period.

Procedure: Have your instructor check out your equipment to see that it works and explain to him how you will set it up and make the recordings. Make a graph or tide chart from your recordings for the two-day period. Be sure and label the days, hours and a.m. and p.m. on your chart.

CHART

Questions:

1. How do the tide changes affect the animal life present on the beach? Why don't they stay in the water all the time?

2. Compare your tide chart with an official tide chart or calendar. How are they different?

Why are they different?

How could you make your tide gauge better?

ADVANCED DRAWING ACTIVITY NO. 1

Materials:

1. Paper (provided)
2. Pencil
3. Animal (provided)
4. Tray

Directions:

1. Draw an animal you think would survive if it lived under a rock below the tidal zone. List its parts and explain why you think it would survive best. Be creative.
2. Draw an animal that isn't fictional, that lives under a rock below the tidal zone. Give the name, phylum, and label.

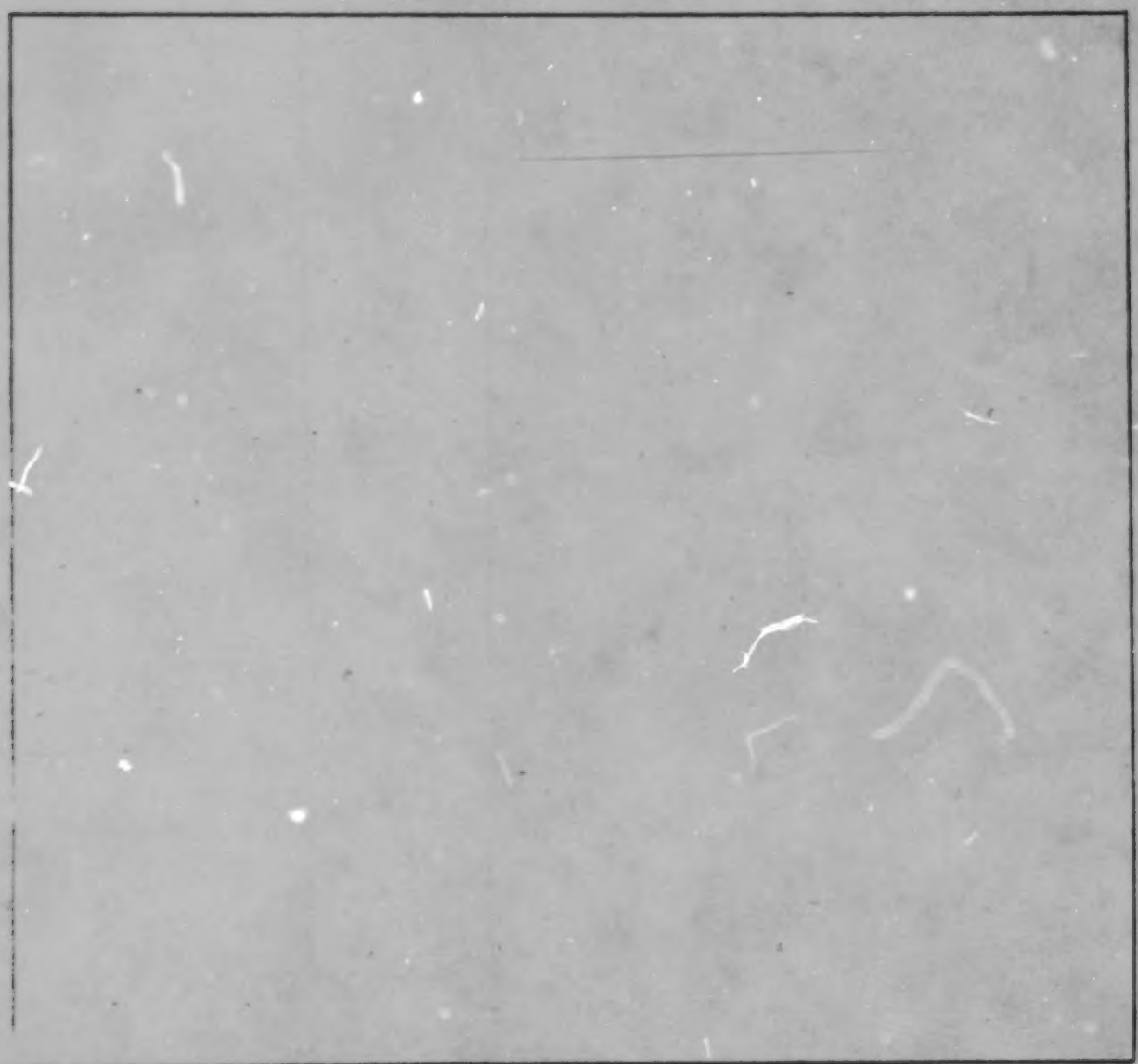
ADVANCED DRAWING ACTIVITY NO. 2

Materials:

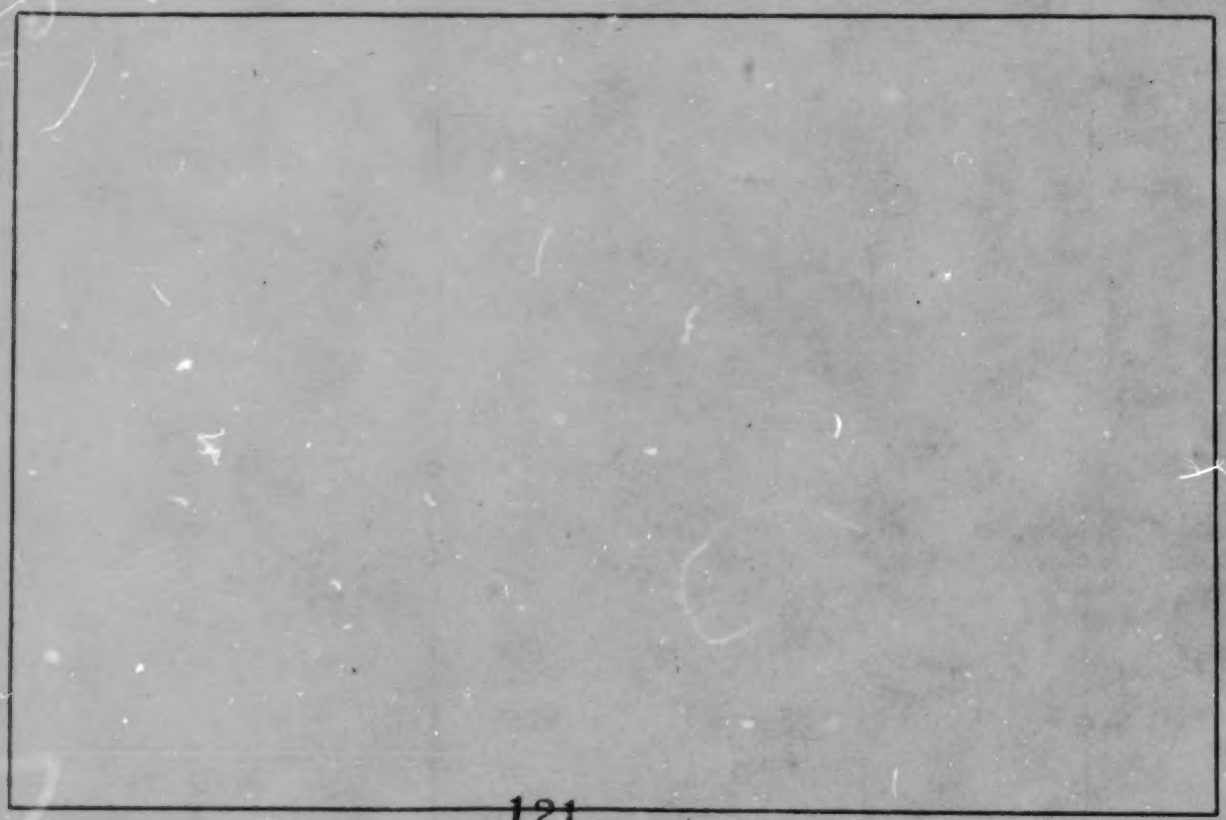
1. Paper (provided)
2. Pencil
3. Animal (provided)
4. Glass petri dish

Directions:

1. Draw in complete detail this animal, label and have a front view, side view and a view from behind.
2. Design your own marine lab and list the kinds of marine animals you would display. Where would you have your lab? On the water, near the water, etc.? This question is to be done on your own paper.



ADVANCED DRAWING ACTIVITY NO. 2 (continued)



GLOSSARY

Explanation: This glossary should be filled with every marine science term that you may be unsure of, or that is new to you. Also, along with the word, you should have the definition in your own words. This is to be kept all year.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
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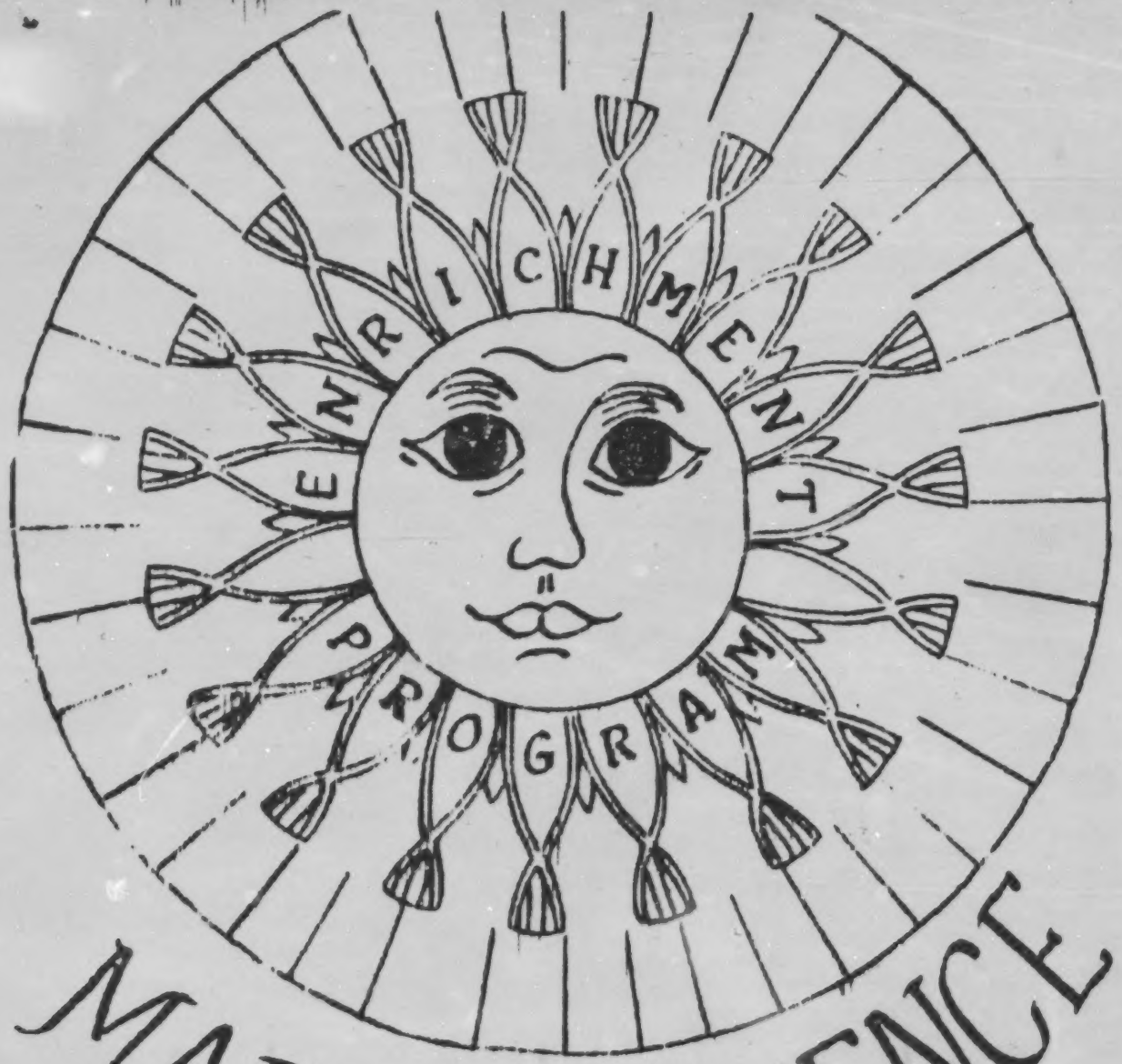
25. _____
26. _____



MARINE SCIENCE

INDIVIDUAL PROJECTS

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Developed under ESEA Title III
North Kitsap School District #400
150 High School Road South
Poulsbo, WA 98370

ADDITIONAL MARINE SCIENCE ACTIVITIES

TO BE USED AS SMALL GROUP PROJECT OR TO BE

ADDED DURING PRESENTATION OF REGULAR CURRICULUM

Individual Project

Animal Report - Animal Classification Sheet

Sea Urchin Response to Light Stimulation

Salinity and Its Effect on Living Tissue

Sponges

Behavior of Hermit Crabs

Currents Lab

Waves

Tides

Elements of Sea Water

Special Projects

FORMAT FOR INDIVIDUAL PROJECTS

Name_____ Grade_____ School_____

A. Title of Project

B. Project Calendar - Time Line

C. What You Hope to Prove or Accomplish

D. Outline of Project

E. Materials List

F. Type of Project

G. Results and Evaluation of Project

H. Oral Presentation to Class at Marine Lab

PROJECT CALENDAR

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
23	29 APRIL Project Initiation →	30	1 MAY	2	3
5	6	7	8	9	10
12	13 Mid-Point Evaluation	14 Check →	15	16	17
19	20	21	22	23	24
26	27 Project Completion →	28	29	30	31

-2-

TIME LINE

ITEM TO BE COMPLETED	TARGET DATE FOR COMPLETION	FINAL DATE OF COMPLETION
Project initiation Area of study selected and title of project chosen		
Completion of project format		
Project completion Project as outlined by researcher is finished and ready for presentation or review		

WHAT YOU HOPE TO PROVE OR ACCOMPLISH
(Project Objectives)

OUTLINE OF PROJECT

TITLE _____

MATERIALS LIST

BOOKS USED FOR RESEARCH			LAB EQUIPMENT
AUTHOR	TITLE	DATE OF PUBLICATION	

TYPE OF PROJECT

RESULTS AND EVALUATION OF PROJECT

POSSIBLE PROJECT IDEAS

--Teach a series of at least three 20 minute lessons on a topic in marine science to a first, second or third grade class or small group of first, second and third grade students in your school.

--Do a study of the raising of oysters as exhibited by the Oyster plant next to the Marine Lab. Schedule several field trips there. Include interviews with the managers or owners; study the life cycle of the oyster; include charts and diagrams.

--Do a written research project of at least six pages of any phase of marine science you have studied or not yet studied that you are interested in. Use books, encyclopedias. Include pictures, charts and graphs to visually complement your written material.

-Make a picture display by drawing at least six marine animals in detail. Label the parts of each. Make these on large sheets (23" x 22") of white or manila tagboard. Complete in one of two ways: (a) black felt pen; (b) color (colored pencils, felt pens, or paint).

-Make a picture display or collage using magazine pictures that show different phases of marine science you have studied. To accompany this, write at least five poems that relate to the different phases of marine science.

-Pick one area of marine science such as plants, animals, or instrument usage. Set up at least two experiments which relate to this area and explain thoroughly how they are set up and what are the results.

-Have your instructor show you the use of the following: parallel rules, compass, charts, dividers, navigation symbols.

Plot the course of a trip showing compass heading, overnight stops, gas stops, food stops.

-Make a study of the Marine Lab. Take pictures and interview the director, Mr. Borden. Find out how it was developed and what its services are today. Make a slide show from your pictures and show these to the class with an oral presentation.

-Make up a student packet of your own in an area of marine science for a first or second grade student. After completion, invite 4-6 students down to the lab from your school. Ask a first or second grade teacher to recommend these students. Have them work on your packet to see if it could be used to teacher marine science at the primary level.

-Collect a group of specimens and perform the following:
Preserve
Identify--common name
scientific name
Give habitat
State ecological relationship (what it eats and what eats it)

-Take vertical and horizontal plankton tow. Take two weeks in a row counting and preserving and listing different types to measure densities. Now decide what important information can be derived from taking these plankton tows.

-Other projects of your choice approved by your instructor.

ESEA Title III
Marine Science

ANIMAL REPORTS

Directions: Choose one animal that you are interested in to do a report on. Make your report as original as possible. (No encyclopedia copying.) Points possible for the reports will depend on your source of valid information.

1. encyclopedia - 25 points
2. magazines - 45 points
3. technical journals or magazines - 65 points
4. your own personal observations from experiments and book resources - 100 points.

All reports must be in your own words except for quotations from your sources. (keep them as short as possible.) List all of your information sources at the end of your report.

It is your responsibility to become an expert on your animal; therefore you need to include the following in your report:

1. Common name of the animal
2. Scientific name of the animal
3. Phylum
4. Where in the marine environment you would find this animal
5. What the animal eats
6. How it eats
7. How it moves
8. How big it gets
9. What are its predators
10. How long it normally lives
11. The life cycle of the animal.

These should be answered in more than one sentence each. (remember - I want a lot of information and facts, not just enough to get you by.)

At the end of your report, answer one of the following questions:

1. How could this animal be commercially valuable? How could you make money from this animal? If it is already commercially harvested, how could you improve the harvesting or raising techniques?

2. How could you make a pet out of this animal? What would you have to do to take care of it? Could you train it to do things?

3. What kind of other animals depend on your animal for survival? Would they die if your animal were not present? Does your animal depend on other animals for a successful existence? How?

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Marine Science

Name_____

Date_____

ANIMAL CLASSIFICATION SHEET

1. Common name of animal_____
2. Scientific name of animal_____
3. Phylum of animal_____
4. Physical characteristics that are similar to those in the phylum and class.
   A. _____
   B. _____
   C. _____
5. Differences between this animal and others in the phylum.
   A. _____
   B. _____
   C. _____
6. List the unique things that you think are interesting about this animal.
   A. _____
   B. _____
   C. _____
   D. _____
7. Draw the best diagram of the animal that you can. Label all parts.

Response of Sea Urchins to Mechanical and Light Stimulation

TIME: One Hour

Stimulate various parts of the urchin (strongylocentrosus drobachenisus), by poking with a fine probe or needle. What is the general response of the animal? _____
What is the local response of the stimulated region? _____
_____ Does Strongylocentrotus purpuratus behave in the same manner as Strongylocentrosus drobachenisas, that is, spines moving in toward a stimulus from a blunt probe and outward in response to a sharp probe? _____
Does the response spread from the localized region if the stimulus is continued or intensified? _____ Can you induce the spines to remain stationary ("freeze") in the defensive position by repeated stimulation? _____
Is it possible, by using a very intense stimulation, to cause the spines to move away from the point of stimulation, thus exposing the pedicellariae?
_____
Can the animal be induced to give a response if the spines are stimulated directly by bending them or crushing them with forceps? _____
_____

Touch a spine and note whether it is rigidly fixed in position or moveable. Now stimulate an adjacent region with a probe and note what happens to the spine under your finger.

Several species of sea urchin, e. g., Strongylocentrosus drobachenisus, exhibit a curious habit of masking or covering themselves with bits of plants, shells, small stones or other handy objects when stimulated by intense illumination. Place specimens of these masking forms in a glass dish lacking rocks or other cover. Provide a few small stones or pieces of shell or algae and observe whether or not the animals will cover themselves. Later provide two or more kinds of covering material at the same time and determine whether there is a preferential selection of masking materials. Will an animal repeat the masking behavior if its previously constructed mask is taken away? _____
Observe the individual movements made during the masking activity.

SALINITY AND ITS EFFECT ON LIVING TISSUE

PROBLEM: What effect does water of different salinities have on living tissue:

MATERIALS:

Two Test Tubes	Sea Water
Rack	Fresh Water
Two Potato Cores	

PROCEDURE:

1. Take two empty test tubes. Fill one 3/4 full of salt water and the other with fresh water. Prop up in a rack.

2. Take two potato cores and describe them.

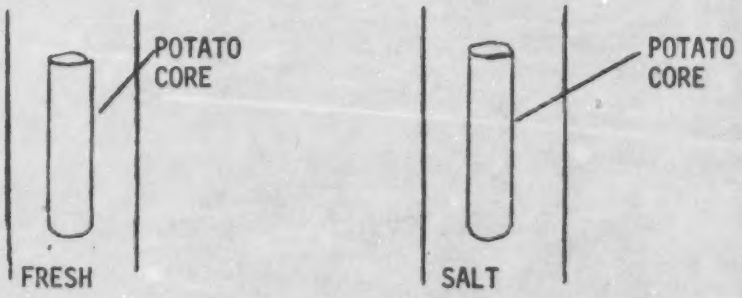
   Place one in each test tube and let sit for ½ hour or more.

3. When time is up remove the potato cores and examine. What has happened to the core left in the salt solution?

   How is it different from the one left in fresh?

   Did fluid enter or leave the potato resting in salt solution?

   In the diagram below, use arrows to show the direction of the flow of water in each case. (Into or out of the potato)



What happens when living tissue is put into water that is too salty?

SPONGES

The purpose of this lab is to study the structure of some common sponges and to learn to identify these sponges.

Materials needed include preserved and living sponges, microscope, slides and coverslips, 10% acetic acid solution, probe, and seawater.

PROCEDURE

1. Place a specimen of sponge A on a clean slide. Find the osculum and pores. Sketch and label. Examine a specimen of sponge A which has been cut longitudinally. Sketch and then label the spongocoel.

2. Place a small piece of tissue from sponge A in a drop of water on a slide. Tease apart the tissue, coverslip, and study under 100 and 400X. Sketch and label any structures or cells that you can identify.

3. Place a small piece of tissue from sponge A in a drop of 10% acetic acid on a clean slide. Coverslip and observe. Bubbles of a gas indicate spicules made of calcium carbonate, $CaCO_3$. The formulas and equation are as follows:

$$CaCO_3 + 2HC_2H_3O_2 \longrightarrow Ca(C_2H_3O_2)_2 + H_2O + CO_2\uparrow$$

4. Examine and sketch sponge B. Test a small bit of tissue with acetic acid as you did in procedure no. 3.

5. Obtain a fresh bit of tissue from sponge B and place it in a drop of seawater. Coverslip carefully and study under 100 and 400X. Sketch and label identifiable parts. Then set the slide apart on a piece of paper labeled sponge B as you will examine the slide later.

6. Repeat procedures no. 4 and no. 5 with sponges C and D, setting aside slide preparations for later study. If slides appear dry, add seawater.

7. On the basis of your observations and using the "Sound and the Sea", identify the sponges.

   A. _____ C. _____

   B. _____ C. _____

8. Examine the slides B, C, and D which have been set aside. Record your observations and suggest an explanation.

Marine Science

Behavior of Hermit Crabs

TIME: One hour

Hermit Crab

The normal habitat of most hermit crabs is the empty shell from a marine gastropod. The abdomen of the crab is coiled and otherwise adapted to fit into the shell. Its center of gravity and leg arrangement are such that it can carry the rather heavy shell from place to place. The animals withdraw into the shells in times of stress and cover the entrance with their chelipeds occluding any invasion. Hermit crabs strongly resist attempts to remove them from the shell. However, when a crab outgrows its shell, it must move to a larger one. This is done quickly to reduce the dangerous exposure of its soft body part.

Induce several crabs to leave their shell by gently applying heat to the side of the shell with a match or other small flame. Be careful or you will cook the crab. Once it has been removed from the shell place the crab in a pan filled with salt water and at equal distances place the original shell and another one as nearly identical to the original shell as possible. Which shell does the crab choose?

Do this experiment with several crabs. Does a trend of activity emerge, i.e., does the crab always choose its original shell?

Place the crab in the pan with only its original shell but plug up the shell opening with paper or wax. What is the reaction of the crab?

Put in a second shell which is too large for the crab. Since it cannot get back into its own shell will it choose one with less than optimal fit?

Place a shell-less crab in an aquarium or suitable pan with shell models or substitutes composed of plasticine or wood. Will the crab approach the models?

Is the shape and size of the model important in attracting the crab?

Do crabs attempt to enter models which have a hole bored in them to mimic the normal shell hole?

CURRENTS LAB

Part A: Effects of Wind

Materials:

1. Tray
2. Dye
3. Water
4. Top of petri dish
5. Finger bowl
6. Assorted shaped objects
7. Lots of hot air

Procedure:

1. Fill the tray with water and let it settle completely. Place a drop of dye at one end and blow gently across the tray. Draw what happens at:

   a. The surface -

   b. On the bottom -

   Are they different? _____

   Why? _____

   _____

   _____

2. Place the finger bowl in the center of the tray to represent an island. Add a drop of dye and supply the necessary wind. Draw what happens to the dye in front and in back of the island.

How is this different from No. 1?_____

_____

_____

3. Repeat the experiment, this time using a submerged petri dish to represent a submarine island. Draw what happens to the dye this time.

How is this different from No. 1 and No. 2? _____

_____

_____

4. Repeat the experiment, this time using any shaped object you can find. Diagram what you experience with the dye this time.

QUESTIONS:

1. Why aren't the currents driven in the same direction as the wind? _____

_____

_____

2. Explain why the top and bottom currents should be altogether different? _____

_____

_____

3. What forces are acting on each current? _____

_____

_____

WAVES

MATERIALS:

1. Pan
2. Sand
3. Wave Board
4. Water
5. Crayon
6. Hot Air
7. Centimeter Rulers
8. Cork

In this experiment we will investigate the different characteristics of waves, so there are several parts to this lab. Each group will have a model of a bay, water, hot air and a board to use as a wave-making device. Follow the steps carefully and answer the questions as you go along. A fan will be available for part A.

Part A: What causes waves to form?

1. Build up the one end of the "bay" so that it is about 3 inches deep at the highest end and gradually slopes down to 1/8 of an inch or less at the end facing the water.

2. Also place a small amount of sand at the deep end of the bay. This represents sediment on the ocean floor.

3. Carefully fill the table with water until the water covers about 2 inches of the shore.

4. Allow the currents in the water to calm down until there is no movement. Then, have one person in the group stand at the ocean end of the bay and blow on the water as hard as he can. What do you observe happening?

   Now blow gently on the water and record what you observe. How does this observation differ from the one before it?

5. Set up the fan so that it will blow across the bay. Put it on low speed and observe what happens.

   If you can, measure the wave length of one of the waves as it moves along the side of the bay. Wave length equals _____. Let the fan blow for about 3 more minutes, then measure a wave length again. Wave length equals _____. How do you account for the differences?

   Turn off the fan, allow the water to settle down, then turn the fan on to high speed. Measure a wave length. Wave length equals _____.

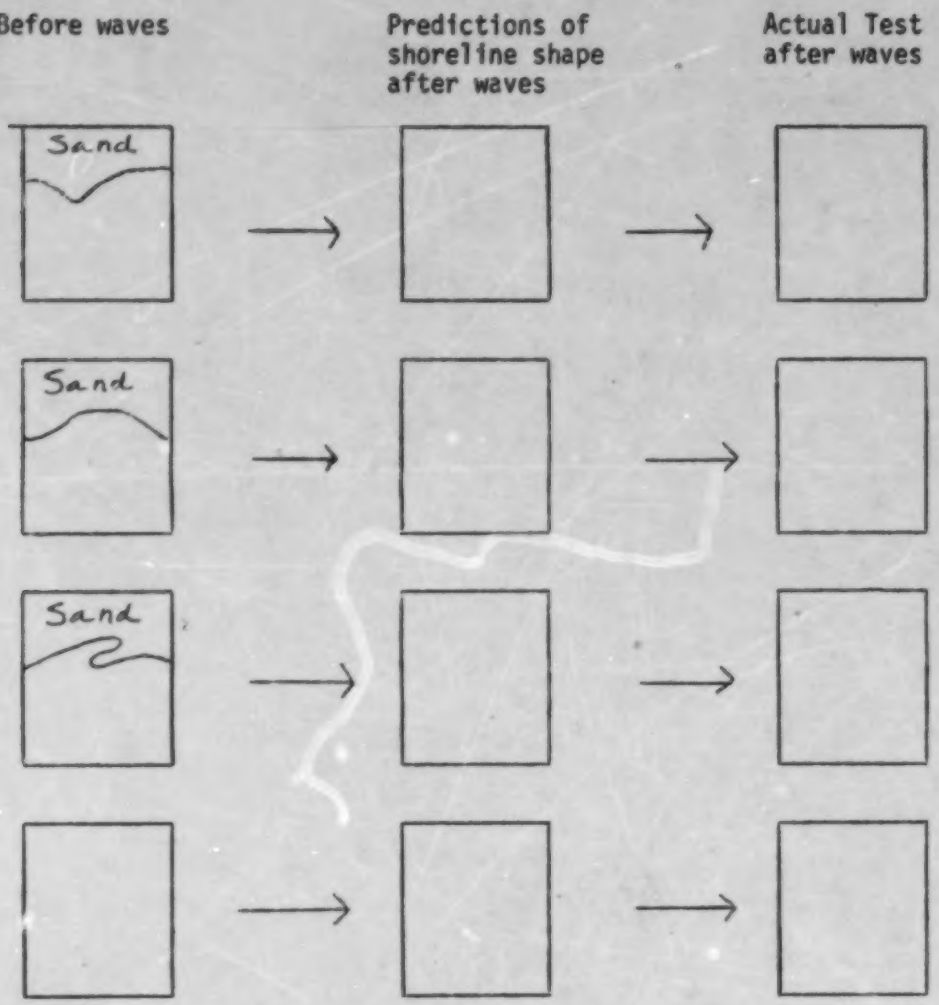
6. From what you observed, what would you say is the major cause of waves on the water of the oceans?

7. How would waves differ on a real windy day from those on a real calm day?

8. Which waves moved faster, the big ones or the smaller ones?

9. What then could you generalize about the waves created from a storm out at sea?

Arrange your shorelines like the diagram below. Follow the directions in Part B.



PART B: How do large and small waves differ?

1. For this part we will create waves by using a 2 x 4 board that will act like a plunger. Waves made in this manner are easier to study than those made by the wind.

2. Place the board in the water so that the 2 inch end is facing up and down. Raise and lower the board straight up and down, using both hands and not letting the board come completely out of the water nor completely under the water. What do you observe happening as the board moves up and down?

3. Move the board up and down twice every five seconds. Record what you see happening to the water.

4. Now move the board up and down every second. How does this observation differ form the one made before?

5. Which waves seem to affect the shoreline more? Why?

6. Which waves (large or small) do you think carried the most energy?

PART C: What makes ocean waves appear to move?

1. Place a very small object (piece of cork) in the water about 5 inches away from the shore. Generate one large wave and observe what happens. Describe the movement of the object.

2. Generate about five large waves and record what you observe happening to the cork.

3. Generate five small waves and record what happens to the cork.

4. Try these steps again with the cork about halfway out into the water.

5. Does the object ever move toward the shore?

6. When does it move the fastest? Why?

7. Does the cork usually move all the way in with one wave?

PART D: What are the parts of a wave? (wave tank)

1. With a crayon or marking pen (something that rubs off), mark on the inside of the basin, the level of water as it is standing still. After you have done that, generate some large waves.

2. As the waves go by, mark the highest level that the crests reach and the lowest level that the troughs reach. Stop the waves and measure the wave height (distance between crest and trough). Wave height equals _____.

3. Generate some large waves again. At exactly the same time you mark the top of a crest of a wave as it goes over a mark you have made, have one of your partners mark the crest of the wave behind it. Stop the waves and measure the distance between the crests. Wave length equals _____.

4. Mark the crest of two waves that are next to each other. Now time how long it takes the crest of a wave to go from one of these marks to the other. The time it takes for your wave to travel that distance is called the period of the wave. What is the period of your wave?

5. To find the wave speed of the waves you are generating, insert the measurements in this formula:

$$\text{wave speed} = \frac{\text{wave length}}{\text{period}}$$

Your answer will be in centimeters per second or inches per second or whatever measurement of length you used. What is the speed of your waves in miles per hour?

TIDES

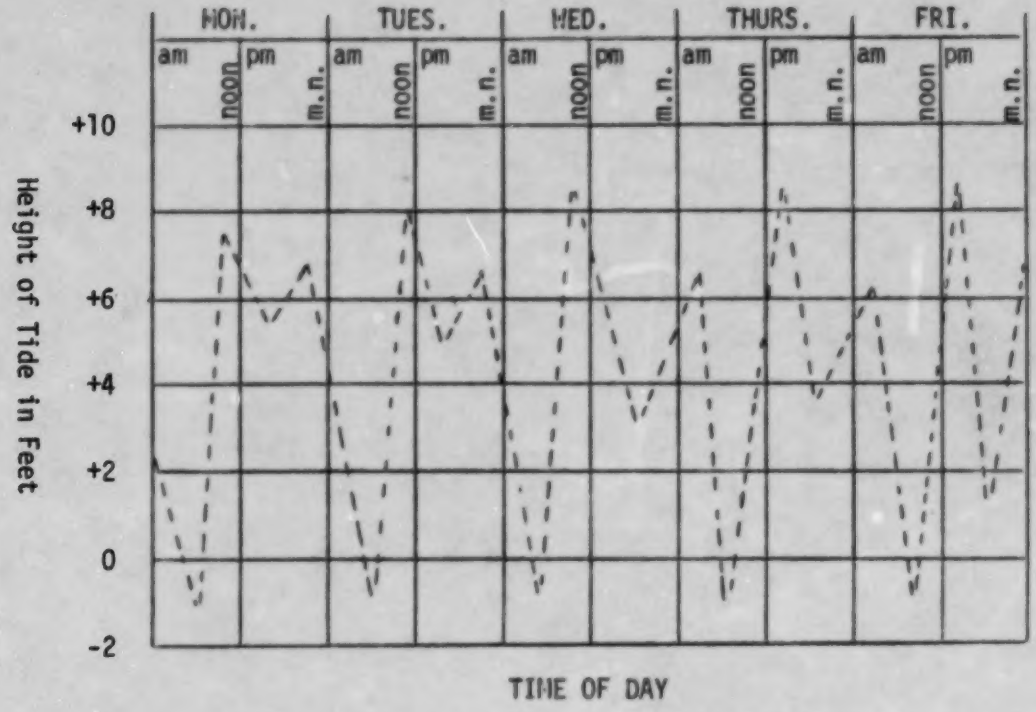
BACKGROUND INFORMATION:

The Types of Tides and the Tide Curve

Nearly everyone has heard about the rise and fall of the tide every day, and nearly everyone has heard that the tides are caused by the gravitational forces of the sun and moon. Information about the tides has always been of great importance to navigation, especially in guiding ships in and out of harbors and operating in shallow waters near shore and around islands. In time of war, a knowledge of the tides of a particular area is essential before an amphibious operation can be planned where boats, men and materials have to landed along some distant shore. Another way in which tidal information is used is in designing generating plants for electricity by the use of tidal energy.

In order to study the tides, we must take observations of the time of rise and fall and the amount of rise and fall of the tide each day over a long period. These observations are usually taken automatically in a tide station by an instrument that rises and falls with the tide and makes a recording. An example of such a recording is collected for various places around the world, certain characteristics of the tide can be discovered and predictions made for the future on the basis of this knowledge.

Sample Tide Curve



TIDES ARE CLASSIFIED AS OF THREE TYPES:

1. SEMIDIURNAL type, which has two high waters and two low waters each day with little or no difference between consecutive high or low water heights. Tides along the east coast on the United States, for example, are of the semidiurnal type.

2. DIURNAL type, which has only one high water and one low water each day. The tides along the Vietnam-China coast are diurnal.

3. MIXED type, which has both diurnal and semidiurnal characteristics. That is, there are two high waters and two low waters each day but with considerable difference between heights of successive high waters or successive low waters; these differences are called DIURNAL (daily) INEQUALITIES. The tides along the Pacific Coast, including Washington, are mixed type.

When the moon and sun are in a straight line with the earth, about every two weeks, they pull together and the tides are the greatest. These are called SPRING TIDES when the water level is higher or lower than normal.

When the moon, sun and earth form a right angle, the pulls oppose each other and the water is nipped or lowered; these are called NEAP TIDES. In the case of neap tides the water neither rises nor goes out very far. These tides occur every two weeks in between the spring tides.

A graph of the rise and fall of the tide can be done by plotting a curve on a graph from predictions of times in hours and minutes, and heights in feet, for specific days. Predictions of tides occuring in the future are made mathematically from past tide observations and from knowledge of the motions of the sun, earth, and moon in space. Predictions are then published in books called TIDE TABLES.

EXERCISE I: OH TIDES

DIRECTIONS: Plot a tide curve from the tide predictions given below. The first day has been plotted on the accompanying graph. Complete the tide curves for days 2, 3, and 4 by plotting the times and heights and connecting all points; then try to answer the questions.

Tide Predictions

Days	Time		Heights
	Hours	Minutes	Feet
1	1	15 a.m.	1.0
	7	30 a.m.	4.1
	4	00 p.m.	1.0
	8	15 p.m.	4.0
2	2	oo a.m.	1.0
	8	30 a.m.	6.5
	2	15 p.m.	2.0
	9	00 p.m.	5.0
3	4	15 a.m.	0.0
	4	00 p.p.	7.0
4	4	30 a.m.	1.0
	10	00 a.m.	3.0
	4	00 p.m.	1.0
	10	00 p.m.	2.9

Questions

1. During what day is the tide diurnal?

   _____

2. During what day is the tide mixed?

   _____

3. During what days is the tide semidiurnal?

   _____

4. During what day is the range largest?

   _____

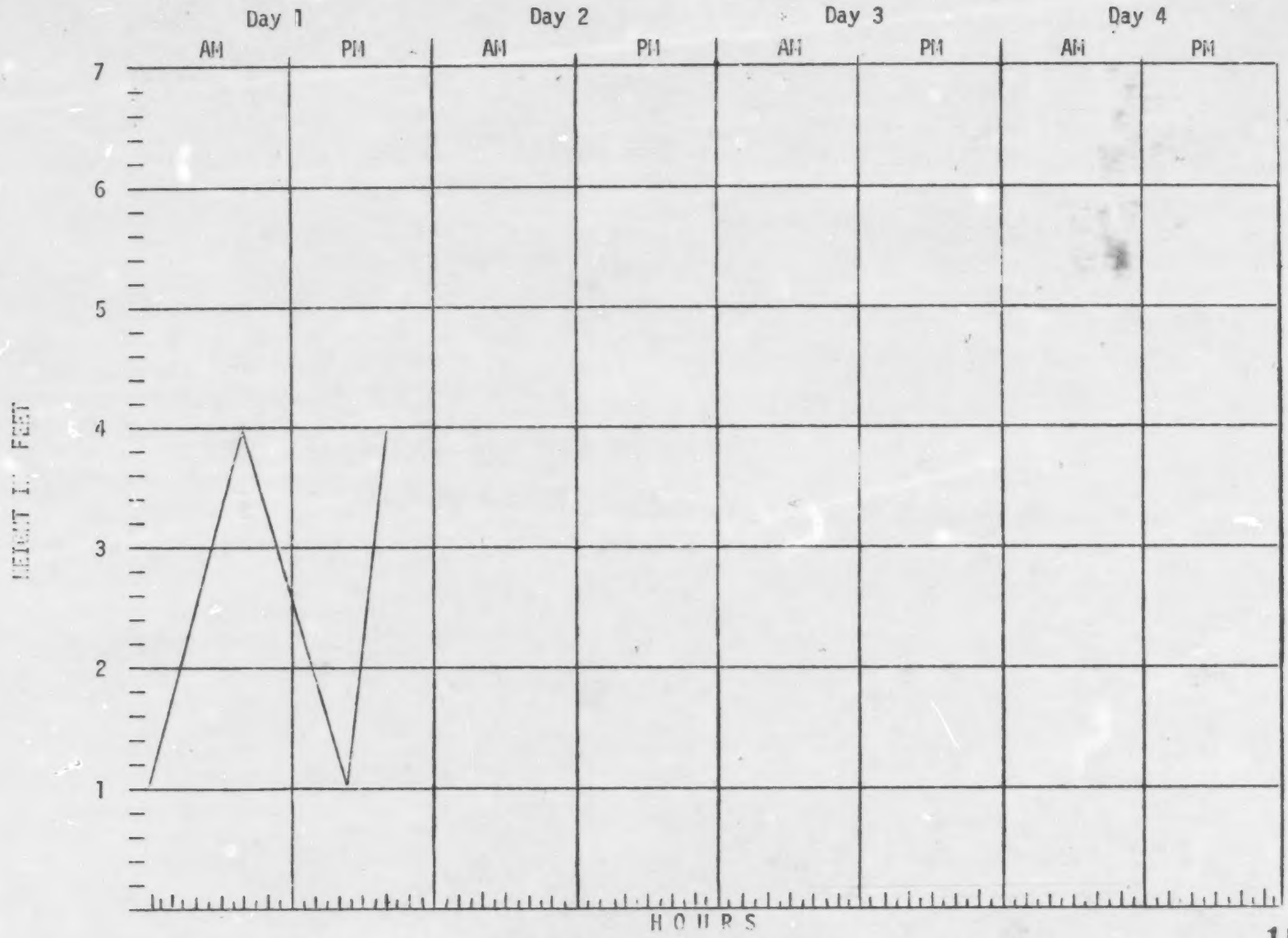
5. What is the smallest range and on what day?

   _____ft. _____days

6. What is the largest diurnal inequality shown?

   _____ft.

   On what day?_____


DAYS
Day 1
Day 2
Day 3
Day 4
AM
PM
AM
PM
AM
PM
AM
PM
7
6
5
4
3
2
1
HEIGHT IN FEET
HOURS

Elements of Sea Water

PROBLEM: What are some of the more common elements found in sea water?

MATERIALS:
- wax pencils
- test tube clamps
- test tube holders
- 3 test tubes
- alcohol burner or heat element
- chemicals (in dropper bottles)
- lab apron
- sea water (in beaker)
- tap water (in beaker)
- distilled water (white bottle)

PROCEDURE:

1. Work in groups of three.
2. As you analyze your samples of water, record your results in the chart below.
3. Mark your test tubes so that you are always using the same one for sea water, the same one for tap water, etc.
4. For each test, first fill your test tube ½ full of the water sample you are testing.
5. These tests do not have to be done in any special order. In fact, if you do them out of order you will avoid getting bogged down waiting for a chemical everyone else is using.
6. Always point the test tube away from yourself or anyone else, especially when heating.

Tests for:	Description of results of tests for:		
	Distilled Water	Tap Water	Sea Water
Calcium			
Sulfates			
Chlorides			
Ammonia			
Organic Matter			
pH			

TESTS:

Calcium - To ½ test tube of water sample, add three drops of acetic acid and three drops of sodium carbonate. Record your observations on the chart. (White precipitate means positive)

Sulfates -To each ½ test tube of water, add three drops of hydrochloric acid and heat to boiling (slowly over an alcohol burner or element.) Then add 3 drops of barium chloride solution. Record the results. (White precipitate means positive).

Chlorides - To each test tube add 3 drops of nitric acid and 3 drops of silver nitrate solution. Record the results. (White precipitate means positive.)

Ammonia - To your water sample add 4 drops of potassium hydroxide and heat gently. Cautiously sniff the test tube and smell the fumes. Record results. (Ammonia smell means positive.)

Organic Matter - To your sample add 2 drops of potassium permanganate solution and 5 drops of concentrated sulfuric acid. Heat to boiling and record any change. (Purple changing to brown means positive.)

pH - To test if your water sample is acidic or not, touch a piece of litmus paper to it and record color of wet end. (Pink means acid, blue means base.)

QUESTIONS:

1. How did the results of the test on tap water and distilled water compare? How pure is the drinking water?

2. Why is there a difference in the results of the tests of fresh water and sea water? What is the real cause of this difference?

3. The ocean is often said to be the "washbowl of the earth." Explain.

4. Explain how the chemicals get into the sea water.

Special Projects' Details

1. Hydrographic relief map -- Using a chart of this area for information, make a three dimensional contour chart out of cardboard. Make sure to mark all streams, towns, etc., and especially the face and elevation scale. See the example at the lab for ideas.

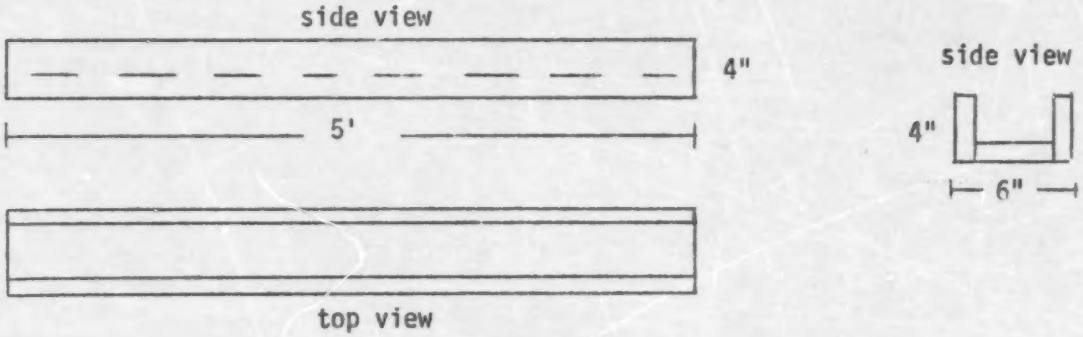
2. Core sample comparisons of different beaches -- Take one or more soil samples on five different type beaches (sand, mud, gravel, loose rock, mixture, etc.). All samples should be about 3" x 3" x 6" deep and kept in containers in the same orientation as the beach. (Don't just shovel in some mud.) Write up brief comparitive observations on how the soil samples are different and how they might have been formed that way by natural forces. Make sure all your samples are at approximately the same level on the tide zone.

3. Core and life samples -- Choose a convenient beach at low tide. Starting at the high tide line, collect a small sample of soil every ten feet or so towards the water line until you come to the water. Put each sample in a separate container for further examination later. Briefly describe the soil type, make-up, and obvious biological life forms present. Tape the description on the outside of each container.

4. Hydrographic sounding chart -- Make a chart on your own, similar to the standard navigation charts, of a <u>small</u> area near your home. Use a lead line for sounding and visual references to plot your soundings. Your boat should have a compass to refer to in making your sounding plots. On your finished chart, be sure to include all standard symbols, colors and a compass rose.

5. Experimental stream table -- Make a stream table to the following dimensions:

   Pack the trough completely full with different soil types of each experiment. Raise the trough about one inch on one end and place a source of running water there (garden hose). Measure the time it takes to erode down to the bottom of the trough at a very slow water speed. Repeat the experiment using a fast water speed. Make sure your water speeds are always the same for each soil type. Draw a picture of the path the water took each time. Explain why there were any differences in time or path pattern in your experiments.



6. Picture comparison of local beach terrain -- Using a camera or sketch pad, show five characteristic beaches around this area. How do they differ in their geographic make-up and position? How are they the same? What were the natural forces that shaped each beach?

7. Navigation -- Using a book on special navigation techniques, tell how you would navigate by the stars, or at night, or open ocean. Make up and navigate an imaginary course for each (celetiar--Vancouver, B. C. to Japan, night--Tacoma to Pt. Townsend, open ocean--Seattle to Hawaii).

APPLICATION FORM FOR MARINE SCIENCE TEACHER'S AIDE

(A) Name_____

Age _____

Phone _____

(B) Previous experience working with upper elementary in a leadership capacity.

_____

_____

_____

(C) Science background (list all junior high and high school courses taken to date).

Junior High	Senior High
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

(D) Other pursuits you have undertaken in the area of science outside of school.

_____

_____

_____

_____

(E) Personal recommendations

1. Fill out first copy evaluating yourself as truthfully as possible.
2. Give second copy to one of your previous science teachers.
   Please send the form and all special recommendations to:

Title III-Gifted

Copy #1

PERSONAL RECOMMENDATION

Candidate's Name _____ Date _____

Name of Reference _____

Upon what is this evaluation based? _____

_____

_____

Consider each area in a broad sense. Circle one number for each trait.

PERSONALITY (Disposition, interacting with others)	10	9	8	7	6	5	4	3	2	1
	Outstanding				Pleasing					Negative
JUDGEMENT (Ability to make wise decisions)	10	9	8	7	6	5	4	3	2	1
	Exceptional				Reasonable					Poor
ENTHUSIASM (Spontaneity, energy level)	10	9	8	7	6	5	4	3	2	1
	Exceptional				Reasonable					Poor
DEPENDABILITY (Integrity, punctuality, responsibility)	10	9	8	7	6	5	4	3	2	1
	Superior				Satisfactory					Doubtful

Probability of Success: (statement) _____

_____

_____

Remarks:

Signed _____

Title III-Gifted

Copy #2

PERSONAL RECOMMENDATION

Candidate's Name_____ Date_____

Name of Reference _____

Upon what is this evaluation based? _____

_____

Consider each area in a broad sense. Circle one number for each trait.

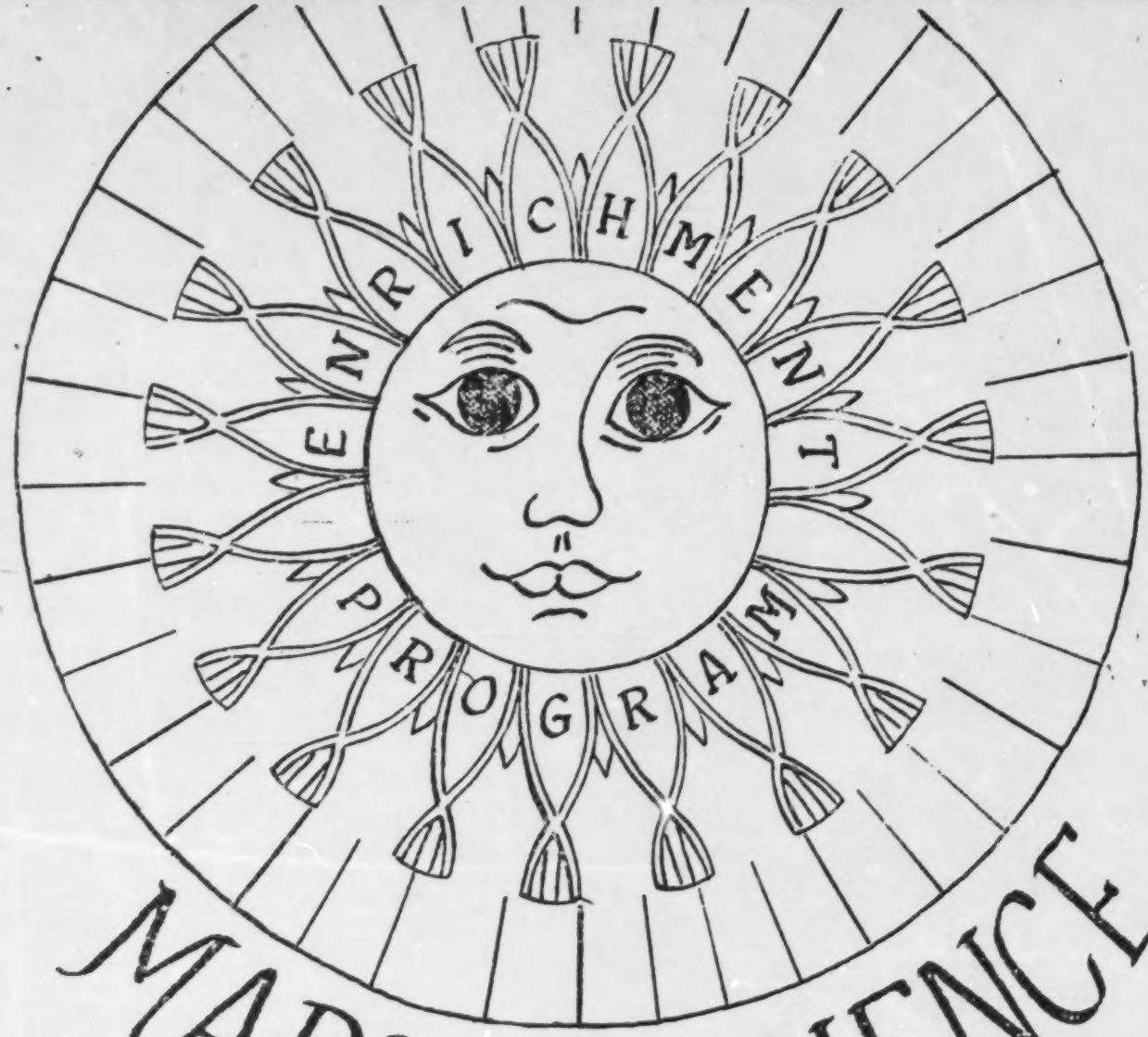
PERSONALITY (Disposition, interacting with others)	10	9	8	7	6	5	4	3	2	1
	Outstanding				Pleasing					Negative
JUDGEMENT (Ability to make wise decisions)	10	9	8	7	6	5	4	3	2	1
	Exceptional				Reasonable					Poor
ENTHUSIASM (Spontaneity, energy level)	10	9	8	7	6	5	4	3	2	1
	Exceptional				Reasonable					Poor
DEPENDABILITY (Integrity, punctuality, responsibility)	10	9	8	7	6	5	4	3	2	1
	Superior				Satisfactory					Doubtful

Probability of Success: (statement)_____

_____

Remarks:

Signed_____



MARINE SCIENCE

BIBLIOGRAPHY

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Developed by
Bryan Demaray

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150 High School Road South
Poulsbo, WA 98370

NORTH XITSAP MARINE ENVIRONMENTAL CENTER
E.S.E.A. TITLE III

OCEANOGRAPHY UNIT NO. 6

Current and/or Recent Books About the
Sea For Juvenile Readers

Prepared for librarians, by Joel W. Hedgpeth

Berrill, Jacquelyn.
Wonders of the Seashore. Dodd, Mead & Co. 1951.

"For anyone from 8 up." Illustrated by the author (unfortunately). However as a professor's wife she is reasonable accurate and the book is a good general introduction without specific reference to either coast.

Carson, Rachel.
The Sea Around Us. Special edition for young readers. Simon & Schuster, New York. 1958

A very attractive, boiled down edition "adapted by Anne Terry White." The illustrations are excellent.

Clarke, Arthur C.
The First Five Fathoms. Harper & Bros. 1960.

About aqua lung diving - for boys. I don't think much of the idea of encouraging this sort of diving at that age. The author is a well known diver, novelist, etc., and the book is reasonably correct.

Clemons, Elizabeth.
Tide Pools & Beaches. Alfred A. Knopf. 1964

A very good, simple book, with the scientific names nevertheless. Treats both coasts, but clearly distinguishes the animals from Atlantic and Pacific. Should be especially useful for elementary teachers as well as students from grade 4 and up. More useful than Vessel & Wong, below.

Daly, Kathleen N.
A little golden book about the seashore. Simon and Schuster, New York. 1957

A trifle often available in drug stores, etc. Used to be $0.25. Probably for first grade, not much higher, I trust.

Ellam, Patrick.
Underwater and sea adventure. Rutledge Books, Frossett & Dunlap. 1961

A so-s- performance for 7th grade or thereabouts, the reproduction of photographs is fuzzy. The Fisher book is better, without some of the peculiar and erroneous author's reminiscences that infest this book.

Engel, Leonard.
The Sea. Life Nature Library. Time Inc., New York, 1961.

This is one of the better volumes of this series. An even more simplified version has been prepared for schools by the Silver Burdett Company (1964), with a teacher's guide and similar trimmings. The page size has been reduced as well as the intellectual content and teachers should use the Engel version for background.

Epstein, Sam and Beryl.
The First Book of the Ocean. Franklin Watts, New York, 1961.

A good general treatment.

Fenton, Carroll Lane,
Wild Folk at the Seashore. John Day, New York, 1959.

The illustrations are excellent but I don't care for the Peter Rabbit approach: "Although Lol was a mollusk, he did not cover himself with a shell."

Fisher, James.
The Wonderful World of the Sea. Garden City Books, New York, 1957.

An attractively illustrated, factually substantial book for junior high level.

Greenhood, David.
Watch the Tides. Holiday House, 1961.

First or Second grade, does attempt to explain the tide at that low level.

Hedgpeth, Joel W.
Introduction to Seashore Life of the San Francisco Bay Region and the Coast of Northern California. University of California Press, 1962.

The publishers thought this long title would sell more copies, and perhaps it has. While not a juvenile, I hope the book is written in such a manner that a reasonably intelligent youngster at 7th grade level can understand it. There is more zoology than usual in a book of this type. The general introductory sections are, I trust, an improvement over the widely circulated Zim and Ingle (q.v.).

Jackson, Caary.
Seashore and Seashore Creatures. A science explorer book. G.P. Putnam's New York, 1964.

Kovalik, Vladmir and Nada.
The Ocean World. Holiday House, 1966.

Very good for junior high level. Continues on where Rachel Carson's junior grade version ends, much more up to date and factual.

Lambert, Elisabeth.
The Living Sea. Coward McCann, New York. 1963

Nice illustrations. Judy and Bill are always looking at the seashore or finding some rare beast. Do young readers really care what Judy and Bill are up to? The same material is covered in several other books already listed.

Liburdi, Joe and Truitt H.
A Guide to Our Underwater World. Superior Publishing Co., Seattle, Washington, 1973.

Smith, De Boyd L.
A Guide to Marine Coastal Plankton. West Coast Plankton Studies. Campbelle, California, 1971.

Smith, Lynnwood.
Common Seashore Life of the Pacific Northwest. Naturegraph Co. Healdburg, California, 1962.

Solem, Alan.
Life Along the Seashore. Encyclopedia Press - True to Life Books. 1963.

Some nice color pictures, but a slight, inconsequential text. Many of the subjects are not found on the Pacific Coast.

Vessel, Matthew F., and Wong, Herbert.
Seashore Life of our Pacific Coast. Fearon Publishers, Palo Alto, 1965.

This book is derived from a number of obvious sources and it is to be regretted that the authors have not seen fit to acknowledge their borrowings, especially of illustrations, although they have been requested to do so. Some common names for eastern forms have been used for Pacific Coast species. The book is on the recommended list of supplementary books for the California Public Schools. Scientific names, however, are not given.

Vogel, Heler Wolff, and Caruso, Mary L.
Ocean Harvest. The future of Oceanography. Alfred A. Knopf, New York, 1961.

A beginner's practical oceanography, simply and clearly written, printed in large (10 pt) widely leaded type.

Williams-Ellism Amabel.
The Unknown Ocean. G. P. Putnam's, New York, 1959.

Adapted from a British book. The same material is in the two preceding titles of this list.

Zim, Herbert S., and Ingle, Lester.
Seashores, a Guide to Animals and Plants Along the Beaches. A Golden Nature Guide. Simon and Schuster, New York, 1956.

This is a popular, easily obtainable pocket book. It concerns both coasts and is neither thorough nor accurate for the Pacific Coast. Much more material of the same nature, based on the California Coast, will be found in my own paper back (adv.).

NORTH KITSAP MARINE ENVIRONMENTAL CENTER
E.S.E.A. TITLE III

OCEANOGRAPHY UNIT NO. 6

EDUCATIONAL MEDIA CENTER
12th & Park
Bremerton, Washington, 98370
(206) ES3-5018

FILMS (F)

F155	Animal Life at Low Tide
F306	Aquarium Wonderland
FL99	Atom Goes to Sea
F962	Beach, The: A River of Sand
F33	Beach and Sea Animals
F467	Birds of the Inland Waterways
F0306	Birds of the Sandy Beach
F468	Birds of the Sea
F119	Boats and Ships
F1012	Challenge of the Oceans: Oceanography
FL60	Clean Waters
F1319	Crustaceans: Lobsters, Barnacles, Shrimp & Relatives
F0298	Earth, The: Coastlines
F798	Earth, The: Its Oceans
F908	Echinoderms, Sea Stars and their Relatives
F307	Field Trip To A Fish Hatchery
F1107	Fish Embryo, The: From Fertilization to Hatching
F105	Fish Family, A
F232	Fish is Food
F246	Fish Out of Water
F0146	Fishing For A Living
F0115	Flipper, The Seal: Background for Reading & Expression
F907	Joint-Legged Animals, The: Arthropods
F273	Latitude and Longitude
F1113	Life Between Tides
F319	Life in the Sea
F845	Life Story of the Oyster
F1254	Life Story of the Sea Star
F185	Life Story of the Snail
F819	Marine Animals of the Open Coast
F1261	Marine Biologist, The
F248	Marine Life
F729	Mollusks: Snails, Mussels, Oysters, Octopus & Their Relatives
F0213	Moon and How It Affects Us
F1540	Mysteries of the Deep
F1072	Oars and Paddles
F872	Ocean Currents
F014	Oceanography: Science of the Sea
F461	Plankton: Pastures of the Ocean
F902	Plankton and the Open Sea
FL35	Restless Sea, The

FILMS (Cont.)

F314	Salmon Story, The
F903	Sea, The
F1544	Sea Gull, The
F113	Seashore Life
F804	Secrets of the Underwater World
F167	Shell Fishing
F1334	Simple Waves
F058	Water Cycle, The
F372	Waves and Energy
F961	Waves on Water
F227	We Explore Ocean Life
FL65	Wealth From The Sea
F911	What is a Fish
F1079	What is Ecology
F0300	Wide, Wide Sea: Background for Reading & Expression

FILMSTRIPS (FS) & SOUND FILMSTRIPS (SFS)

FS243	Continents and Oceans
FS795	Oceanographic Tower
FS806	Underwater Acoustics
FS180	Oceans of the World
FS939	The Seas Around Us
FS613	Wind and Waves
FS2419	Wealth in the Ocean
FS1707	Latitude, Longitude and Time
FS1712	The Waters Around Us
FS1573	The Coral Reef
FS2778	Mighty Currents of the Sea
FS2479	The Oceans
SFS68	Understanding Oceanography
SFS88	Oceanography: Studying Our Deep Frontier
SFS176	Science of the Sea
FS427	Chitons, Tooth Shells, Clams and Octopus
FS594	Crustaceans
FS692	Sea Stars and Their Relatives
FS325	Sponges, Coelenterates and Ctenophores
FS9	Low Tide at the Beach
FS984	Life In An Aquarium
FS2740	Seal Island
FS2744	Water Birds
FS1249	Tidal Pool Zoo
FA2472	Animals of the Sea and Shore - Gr.2
FS2753	Some Water Animals
FS853	How Fish Get Their Food
FS407	Birds of Sea and Shore
FS286	Keeping An Aquarium
FS287	Plants and Strange Animals of the Sea

FILMSTRIPS & SOUND FILMSTRIPS (Cont.)

FS288	Shellfish of the Seashore
FS353	The Seashore: A Continually Changing Environment
FS1375	Miracle of the Sea
FS454	Using Latitude and Longitude
FS1656	The Oceans
FS2779	Landscapes of the Sea
FS725	Harvesting the Crab
FS726	The Crab Cannery
FS81	Clipper Ships Sail the Seas
FS569	U.S. Coast Guard
FS397	Harbors and Ships
FS1198	Let's Visit an Ocean Liner
FS2086	Trip by Ship
FS1098	The Tugboat
FS1100	The Freighter
FS1101	The Fireboat
FS1102	The Harbor
FS1103	The Lighthouse